MODEL V-1070

OSCILLOSCOPE

OPERATION MANUAL

Hitachi Denshi, Ltd.

WARRANTY

This Hitachi Denshi, Ltd. product is warranted against defects in workmanship and materials. If any failure, resulting from a defect in either workmanship or material, shall occur under normal use within two years from the original date of purchase, such failure shall be corrected free of charge to the original purchase by repair or, at Hitachi Denshi's sole option, replacement of the defective part or parts. No charge shall be made for labor or services performed during said two years period providing the product is brought to our Authorized Service Station.

Hitachi Denshi, Ltd. will either repair or at its sole option, replace any part except for cathode ray tube, fuses, probes, lamps, batteries and other optional materials which are defective in either workmanship or material under normal and proper use.

This warranty does not cover equipment which has been tampered with in any way, or damage caused by accident, negligence, alteration, or misapplication.

This product must be returned transportation prepaid, properly packed and insured. This warranty applies only to the original purchaser.

NO OTHER WARRANTIES ARE EXPRESSED OR IMPLIED. Hitachi Denshi, Ltd. IS NOT LIABLE FOR CONSEQUENTIAL DAMAGES.

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NOTE

- This instrument should be adjusted at an ambient temperature of +20°C for best overall accuracy.
  Allow at least 15 minutes warmup before proceeding.
- Polyvinyl chloride (PVC) film is attached on the enclosure and the front panel of the oscilloscope to protect the metal surface. If the PVC film is damaged by scratches, remove it.
- To clean the enclosure or the front panel, use neutral detergent. Refrain from using thinner, benzine, alcohol or other chemicals.
- For safety operation, be sure to connect the ground lead of the GND (ground) terminal to earth ground, if a two-wire AC power system is used.
  Failure to complete the ground system may allow the chassis and cabinet of this instrument to be elevated above ground potential and pose a shock hazard.

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1. FEATURES

The Hitachi V-1070 is a portable read-out oscilloscope with a bandwidth of DC to 100 MHz. The V-1070 is designed with a new concept and provides measurement reliability and ease of operation by employing a microprocessor.
The major features are:

(1) Character display of set-up information

The measurement information is alphanumerically displayed on the CRT as shown below;

* VOLTS/DIV setting of Channels 1 and 2.
* TIME/DIV of A and B
* CAL or UNCAL
* Converged data at MAG mode
* Delay time
* CH2 INVERT mode
* 20 MHz Bandwidth Limit mode
* ADD mode
* Trigger source
* Input coupling mode

Since troublesome setting operation procedures are eliminated, an operator can concentrate on the displayed data for measurement.

(2) Four channel inputs

In addition to Channels 1 and 2, Channels 3 and 4 have 0.5V/DIV or 0.1V/DIV deflection sensers that are most useful for digital measurement.

(3) Wide bandwidth

Wide frequency bandwidth from DC to 100 MHz is available.

(4) High sensitivity

High sensitivity of 1 mV/DIV is ensured.

(5) Internal graticule

Internal graticule lines eliminate parallax-viewing error between the trace and the graticule lines.

(6) Delayed sweep

With delayed sweep, a partial signal can be magnified for measurement. The delayed time is digitally displayed.

(7) TV triggering

New circuit technology provides stable TV signal measurements.

(8) Alternate triggering

Input signals of Channels 1 and 2, which are out of synchronization, can be triggered.

(9) Ground free run

Sweep free runs in the NORM mode when the input coupling, whose channel is set for a trigger source, is GND. In the ADD VERT MODE, sweep free runs by setting the input coupling of CH1 and CH2 to GND.

2. ACCESSORIES

The V-1070 Oscilloscope is shipped with the following standard accessories:

2 Probes (AT-10AL 1.5)
1 AC power cord
1 Operation manual
1 Fuse (2A for 100V AC and 120V AC Power source, or 1A for 220V AC and 240V AC Power source)
1 Dust proof cover

3. PRECAUTIONS

Precautions should be observed to lengthen the service life of this instrument.

Installation site

* Avoid installing this instrument in an extremely hot or cold place.
  - Avoid placing this instrument in a place exposed directly to sunlight for a long period of time, in a closed car in midsummer, or near a heating device.
  - The maximum operating ambient temperature is 50°C.
* Do not use instrument that has been left outdoors on a cold winter day. The operating ambient temperature is -10°C or more.
* Avoid moving the instrument rapidly from a hot to a cold place and vice versa, since condensation may form on inside of the instrument.
* Keep the instrument away from damp air, water, and dust. Unexpected trouble may be caused when the instrument is placed in a damp or dusty place.
  The operating ambient humidity is 35 to 85%. Since an accidental intrusion of water may also cause troubles, do not place a fluid-filled containers, such as a coffee cup on the oscilloscope.
* Do not place the instrument in a place where vibration

is strong. Avoid using the instrument at a place vibrating violently. Since the oscilloscope is a precision instrument, excessively strong vibrations may cause damage.

* Do not place the instrument near a magnet or magnetic body. An oscilloscope uses an electron beam, therefore, do not bring a magnet close to the instrument or do not use the instrument near any equipment generating strong magnetic fields.

Handling

* Do not put a heavy object on the oscilloscope.
* Do not block the ventilation holes.
* Do not apply a heavy shock to the oscilloscope.
* Do not insert a wire, pin, etc. through the ventillation holes.
* Do not drag or carry the set, leaving the probe attached to it.
* Do not leave a hot soldering iron on the cabinet or the screen.
* Do not set the instrument on its face, oterwise, knobs may be broken.
* Do not use the instrument upright, leaving BNC cable connected to EXT BLANKING, GATE OUTPUT, CH1 OUTPUT terminals on the rear panel. The cables may be damaged.

Faulty operation

* Recheck the operating procedure. If problem persists, contact the nearest service facility.

Care and repair

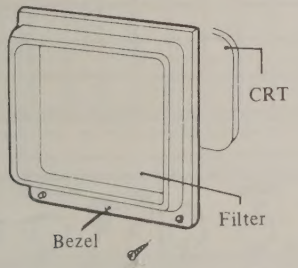
* **Removal of stain from the case**
  - When the outside of the case is stained, remove the stain by first wiping it lightly with a cloth moistened with neutral washing agent and then wipe the surface with a dry cloth.
  - When the panel surface is stained, remove the stain with a clean, soft cloth. When heavy stains are present, first remove the stains by wiping the surface lightly with a cloth moistened with a diluted neutral washing agent and then wipe thoroughly with a dry cloth.
  - When dust has accumulated inside, remove it by using a dry brush, or by using the exhaust of a compressor or a vacuum cleaner.

NOTE:
When opening the case, disconnect the power supply plug beforehand.
When cleaning the inside, may sure that no electricity remains in the condensers of the power supply circuit.

* **CRT cleaning**

Dirty surface on the CRT screen tends to cause measuring errors. Remove the stains on the CRT and filter by using a clean soft cloth, paying attention not to damage the surface. When the stain is extremely heavy, wash them with a neutral washing agent and then leave them stand until the moisture is removed naturally.

- If the screen is installed while it is moistened, water rings may be formed and the waveform may be blurred. Also, pay attention not to leave finger prints on them.



Maintenance

(1) Use and store the oscilloscope carefully, not to damage the built-in precise components.

(2) Clean the CRT screen and the scale plate from time to time with a clean soft cloth.

(3) Side panel can be removed by unscrewing the screws.

(4) Store the oscilloscope under ambient temperature of from -20 to 70°C.

Cautions to be observed before measurement

* **Line voltage check**

The operating voltage range of this oscilloscope is shown below. Check the line voltage without fail before turning on the power switch.

Rating	Line voltage (50/60Hz)
100V AC	90 – 110V AC
120V AC	108 – 132V AC
220V AC	198 – 242V AC
240V AC	216 – 264V AC

Before shipment, the voltage selector is set conveniently for user. When it is intended to use the oscilloscope on the other voltages rating. The voltage selector must be changed. (Rated voltages are indicated on the rear panel of the oscilloscope.)

* **Use only specified fuses.**

In order to protect the circuit against over current, a 2A (100V AC or 120V AC) or 1A (220V AC or 240V AC) is

used on the primary side of the power supply. When this fuse is blown out, thoroughly check for the cause, repair any faults present, and then replace with a specified fuse. Do not try to use the fuse other than the specified ones. Otherwise, a fault may be caused or damage may be invited. (Particularly, do not use a fuse different from the specified one in current capacity and length.) The standard for the fuses are as follows.

	Shape (Diameter x length) mm	JIS type name
2A	6.35 x 31.8	MF61NM250V 2A AC
1A	6.35 x 31.8	MF61NM250V 1A AC

* **Do not increase the brightness too much.**

Do not increase the brightness of the spot and trace too much. Your eyes may be strained and the fluorescent sur-safe of CRT may be burnt.

* **Do not apply an excessive voltage.**

The maximum input voltage of each connector and probe is as follows. Never apply a voltage higher than specified.

INPUT direct	400V (DC + peak AC at 1 kHz)
With probe	500V (DC + peak AC at 1 kHz)
EXT BLANKING	20V (DC + peak)

Calibration interval

To maintain instrument accuracy, perform the calibration of the V-1070 at least every 1000 hours of operation, or every six months if used infrequently.

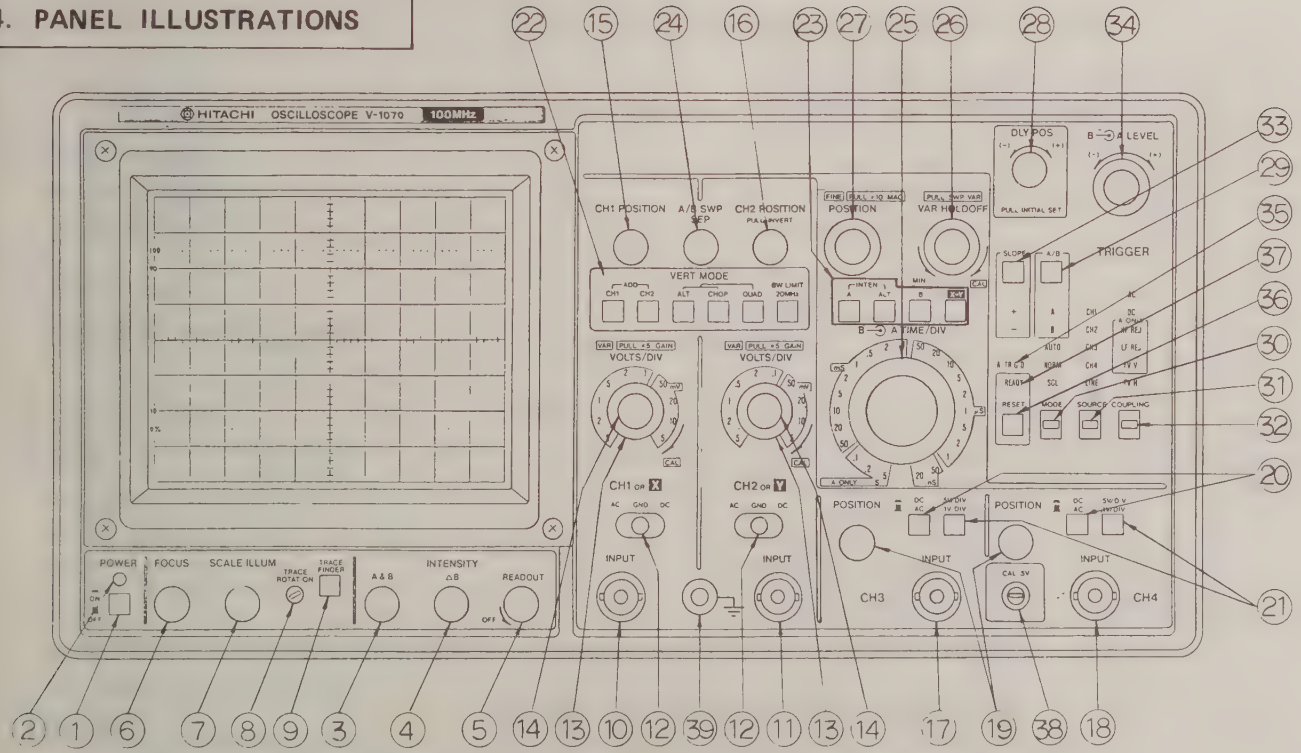


Fig. 4-1 Front View

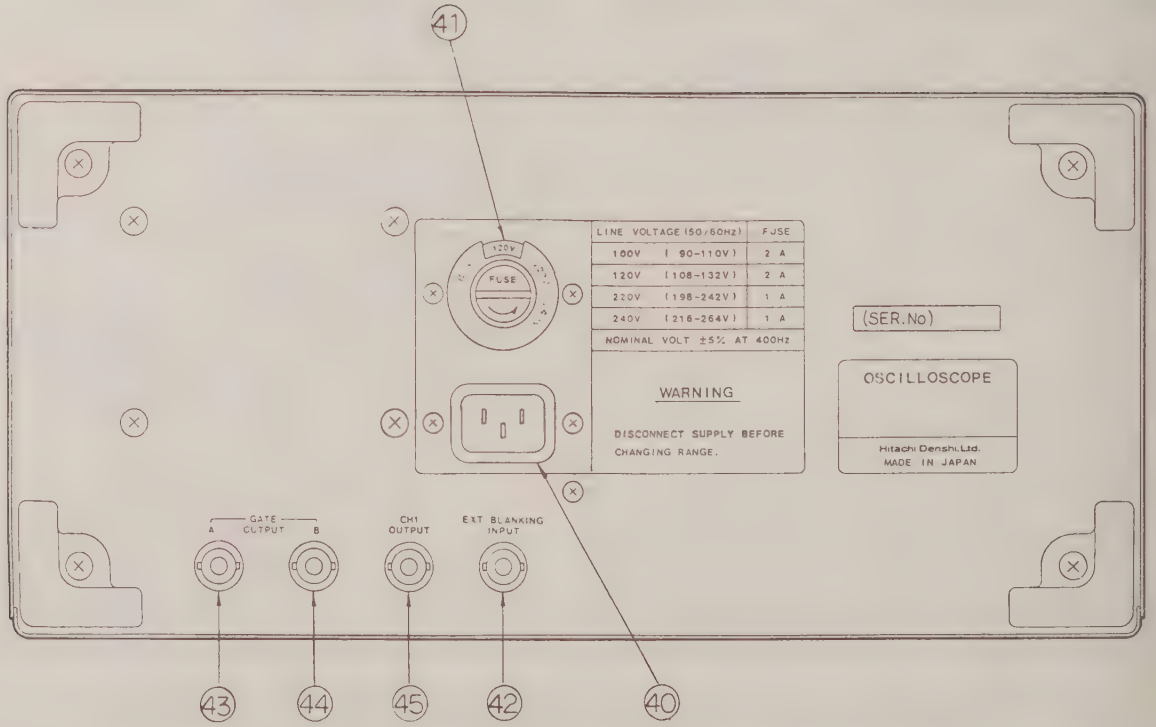


Fig. 4-2 Rear View

5. PANEL DESCRIPTION

(1) Power and CRT

(1) POWER switch

Power is ON in the depressed mode (⊓), and OFF in the released mode (⊔).

(2) POWER lamp

Lights up in red with POWER ON.

INTENSITY controls

(3) A & B

Adjusts the intensity of the main sweep (A) and the delayed sweep (B). Clockwise adjustment increaes intensity.

(4) △B

Adjusts the intensity of the delayed sweep (B). Clockwise adjustment increases intensity.

(5) READOUT

Adjusts the intensity of characters displayed on the CRT. Fully counterclockwise rotation disables characters display.

(6) FOCUS control

After obtaining an appropriate brightness by operating the INTENSITY control, adjust the FOCUS control until the trace has best definition. Although the FOCUS is corrected automatically when the INTENSITY control is rotated, the focus can be slightly shifted. In this case, adjustment is required.

(7) SCALE ILLUM control

Controls graticule illumination. Useful when photographing or viewing waveforms in a dark area.

(8) TRACE ROTATION control

Corrects a slight tilting of trace caused by external magnetic fields. Align the trace with the horizontal graticule line by rotating the control.

(9) TRACE FINDER switch

Compresses the display within the graticule area, when the trace is located off-screen.

(2) Vertical deflection system

(10) CH1 or X INPUT connector

This BNC connector provides external signal to Channel 1.

The applied signal is supplied to the horizontal deflection system in X-Y operation.

(11) CH2 or Y INPUT connector

This BNC connector provides external signal to Channel 2. The applied signal is supplied to the vertical deflection in X-Y operation.

(12) AC-GND-DC switches

Select the method of coupling the input signal to the vertical deflection system.

AC: Input signal is capacitively coupled to the vertical attenuattor. The DC component of the input signal is blocked.

GND: The input of the vertical amplifier is grounded to provide a ground reference. This provides ground free run function in NORM of the trigger mode.

DC: All frequency components of the input signal are coupled to the vertical attenuator.

(13) VOLTS/DIV switches (CH1 and CH2)

Selects the sensitivity level of the input signal to Channels 1 and 2 in 10 steps from 5mV/DIV to 5V/DIV.

The deflection factor set by these switches is shown on the lower left side of the CRT. In the case of a 10:1 probe, multiply the displayed value by 10 times.

The deflection factor corresponding to probes can be displayed by following the procedure of Item 8-(1)-(b).

(14) VAR PULL x5 GAIN controls

* Provides a continuous variable deflection factor. Attenuation of less than 1/2.5 is obtained by counter-clockwise rotation.
* This control is used when comparing two waveforms or when measuring the rise time of a square wave.
* To measure a voltage by the use of the deflection factor indicated by VOLTS/DIV, turn the VAR control clockwise fully to the CAL position.
* When the control is pulled, the vertical deflection factor at each range of VOLTS/DIV is magnified to 5 times.

  The maximum deflection factor is obtained at 1 mV/DIV.

NOTE:

1. When the control is pulled, the S/N ratio and frequency bandwidth of instrument will be reduced.
2. Observation of signals in the high-sensitivity range of 1 mV to 2 mV/DIV and in the CHOP mode, it is sometimes difficult to obtain a stable trigger.
   a. Put a high level synchronization signal into the vacant channel as trigger signal source.
   b. For observing low frequency signals under 50 kHz, select the HF-REJ by the COUPLING switch in the A trigger mode.

(15) CH1 POSITION c ıtrol

Sets vertical position of the Channel 1 signal display. Clockwise rotation moves the associated trace upward while counterclockwise rotation moves it downward.

(16) CH2 POSITION PULL INVERT control

* Sets vertical position of the Channel 2 signal display. Clockwise rotation moves the associated trace upward while counterclockwise rotation moves it downward.
* When the control is pulled out, the signal polarity of Channel 2 is inverted.
  Useful for the comparison of two signals of opposite polarities and for the observation of the difference between Channels 1 and 2 in the ADD mode.

(17) CH3 INPUT connector

The BNC connector provides external signal to Channel 3.

(18) CH4 INPUT connector

The BNC connector provides external signal to Channel 4.

(19) POSITION controls

Set vertical positions of Channel 3 and Channel 4 signal displays.

(20) DC/AC switches (CH3 and CH4)

Sets input coupling to Channels 3 and 4. AC coupling is accomplished with the function switch out (⊓), while DC coupling is with the function switch in (⊓).

(21) .5V/DIV–.1V/DIV switch

Set the deflection factor of Channel 3 or 4 to .5V/DIV, function switch in (⊓) or .1V/DIV, function switch out (⊓).

(22) VERT MODE switches:

CH1 switch	Displays the Channel 1 signal.
CH2 switch	Displays the Channel 2 signal.
ADD switch	Displays the algebraic sum of Channels 1 and 2, when the both CH1 and CH2 buttons are latched in.
ALT switch	Chennel 1 and 2 signals are alternately displayed at each sweep. Used for the dual trace observation of flicker free waveforms in the sweep time ranging from 0.5 ms/DIV to 20 ns/DIV.
CHOP switch	Channel 1 and 2 signals are switched at about 250 kHz rate regardless of the sweep and they are simultaneously displayed on the CRT.

This is used for dual trace observation of waveforms in the low sweep time ranging from 1 ms/DIV to 0.5 s/DIV. To prevent triggering from noise occured at chop switching, select the COUPLING switch to the HF REJ or set the A trigger LEVEL control to the optimum level.

QUAD switch Quad signals of Channels 1 to 4 are all displayed by pressing the QUAD button, with the ALT or CHOP buttons depressed.

BW LIMIT-20 MHz switch Reduces interference from undesired high-frequency signals when viewing low-frequency signals.
Reduces the bandwidth of Channels 1 and 4 to approximately 20 MHz.

(3) Horizontal deflection system

(23) Horizontal display switches:

Provides for selecting the operation mode of the horizontal deflection.

A switch Main sweep (A) appears on the CRT. This setting is used in normal cases.

ALT switch Both main sweep (A) and delayed sweep (B) are displayed alternately.

INTEN switches Intensifies the main sweep (A) for the duration of the delayed sweep (B) by pressing both the A and ALT switches.

B switch Magnifies the intensified portion of the main sweep (A) over the full screen. The sweep time is controled by the B time base.

X-Y switch Used for an X-Y operation. Signals applied to Channels 1 and 2 become signals of X axis and Y axis respectively.
The vertical deflection factor is read on CH2 VOLTS/DIV and horizontal deflection factor on CH1 VOLTS/DIV.
CH1 POSITION control sets horizontal position of the waveform and CH2 POSITION control sets vertical position in the X-Y mode.

(24) A/B SWP SEP control

Adjusts the vertical position of the delayed sweep (B) in the ALT sweep mode.

(25) A TIME/DIV switch (outer)

Sets the sweep speed of the main sweep (A) in 23 steps from 20 ns/DIV to 0.5 s/DIV.

(25) B TIME/DIV switch (inner)

Sets the sweep speed of the delayed sweep (B) in 20 steps from 20 ns/DIV to 50 ms/DIV.
The scale factors of the A and B TIME/DIV switches are displayed on the lower right side of the CRT.
The independent setting is available by the two knobs.

(26) PULL SWP VAR control (inner)

Continuously varies the sweep speed of the main sweep (A) when the control is pulled out.
The sweep is delayed by 2.5 times or more at the fully counterclockwise position.
Normally, the knob is left depressed.

(26) VAR HOLDOFF control (outer)

Increases the holdoff time to trigger and aids triggering on complex displays such as high-frequency signal, irregular signal and digital words.
Rotate the VAR HOLDOFF control to obtain stable triggering. Normally, set this control to MIN.

(27) POSITION control (outer)

Used to adjust the horizontal position. Display is moved to right side when the control is rotated clockwise and to left side with counterclockeise rotation. The outer shaft is for coarse adjustment.

(27) FINE PULL x10 MAG control (inner)

The inner shaft for fine adjustment is described below. A and B sweeps are magnified to 10 times by pulling out FINE knob (inner shaft) of horizontal POSITION control (27). In this case the sweep time is 1/10 the value indicated by TIME/DIV. Bring the portion of the waveform to be magnified to the center of the scale by the horizontal POSITION control (27). Then pull the x10 MAG switch and the waveform placed at the center is magnified.
By controlling the PULL x10 MAG, sweep speed becomes 10 times the sweep set by the TIME/DIV control and the sweep rate displayed on the CRT becomes 1/10 the sweep time set at initial time.

(28) DLY POS control

Used to set the delay time of the delayed sweep (B) starting point with respect to the main sweep (A) starting point. The delay time is displayed on the upper left side of the CRT.
Depress and turn this control to move cursor fast.

(4) Trigger system

(29) A/B switch

Selects either A trigger or B trigger, when the ALT, INTEN, or B is selected for the horizontal display.
The A or B LED lights up to indicate the selected mode.
The LEDs of the MODE, SOURCE, and COUPLING switches light up corresponding to the selected mode.

(30) MODE lever switch

Sets the triggering mode to AUTO, NORM, or SGL. The selected mode LED lights up by change the lever position.

AUTO The instrument will automatically display a sweep without an input signal being applied or out of trigger.
Normal trigger will be established by setting trigger level when a signal is applied to the input.
This setting is convenient in most cases.

NORM No sweep will appear, unless a signal is present or out of trigger. Use this MODE when effecting synchronization to a very low frequency signal (30 Hz or less).
Sweep free runs in the NORM mode when the input coupling, whose channel is set for a trigger source, is GND.
In ADD VERT MODE (22), sweep free runs by setting the input coupling of CH1 and CH2 to GND.

SGL Displays a single sweep by A trigger source. Used for photography.

NOTE:
The trigger system is set to READY when pressing the RESET button. The readout disappear and will reappear at completion of the single sweep.

(31) SOURCE lever switch

Selects the triggering signal source and the associated LED lights up.

CH1 The signal applied to CH1 is selected for the source.

CH2 The signal applied to CH2 is selected.

CH3 The signal applied to CH3 is selected.

CH4 The signal applied to CH4 is selected.

LINE The frequency of the mains (AC power) is selected.
Functions only in the A trigger mode.

NOTES: When LINE is selected in the A trigger mode. B trigger is automatically set to the AUTO mode.

CH1
CH2 Both LED's CH1 and CH2 light up when the source switch is in the down LINE position and the VERT MODE is set to ALT in the A trigger mode. This indicates alternate trigger mode. CH1 and CH2 signals can be triggered even if the two signals have no relationship of synchronization the trigger COUPLING will be automatically set to DC in this mode.

(32) COUPLING lever switch

Selects coupling method for the triggering signal.

AC Blocks DC and cuts off the very low frequency components.

DC Directly connects the triggering signal to the trigger circuit.
Used when triggering by a very low frequency signal.

HF REJ Among the AC component for triggering, the high frequency components of more than 50 kHz will be attenuated.
A stabilize trigger will be unaffected by noise of more than 50 kHz, can be obtained.

LF REJ Among the AC component for triggering, the low frequency components of less than 50 kHz will be attenuated.
A stabilized triggering will be unaffected by noise of less than 50 kHz, can be obtained.

TV-V Used when observing the entire vertical video signal.

(HF-REJ, LF-REJ, and TV-V function only in the A trigger mode.)

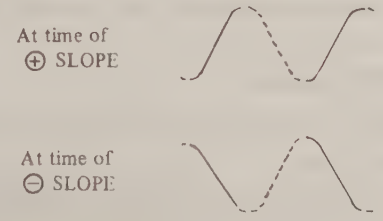
TV-H Used when observing the entire horizontal video signal.

NOTE:
When TV-V is selected in the A trigger mode, TV-H is automatically established in the B trigger mode.

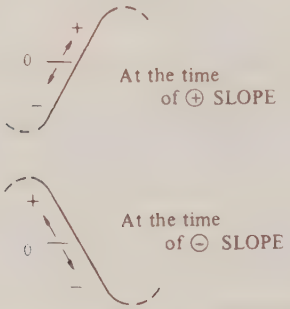
(33) SLOPE switch

Selects the triggering polarity of (+) or (-). The (+) or (-) LED lights up to indicate the selected polarity.

Explanation of trigger polarity SLOPE



Explanation of trigger LEVEL



(34) A LEVEL control (outer)

Sets the triggering level of the main sweep (A).

(34) B LEVEL control (inner)

Sets the triggering level of the delayed sweep (B).
By controlling the trigger level, the sweep start point of the waveform is set.

(35) A TRIG'D indicator

Lights up when the main sweep (A) is triggered.

(36) RESET switch

Resets triggering circuit when the MODE lever switch is set to SGL.

(37) READY indicator

Lights up to indicate that the oscilloscope is ready for single sweep.

(5) Miscellaneous

(38) CAL 0.5V terminal

A 0.5V–1kHz squarewave signal is available through a tip terminal for probe calibration.

(39) GND terminal

Earth terminal grounding.

(6) Rear panel

(40) AC input connector

Provides the connection point for the AC power source to the instrument.

(41) FUSE holder

Install a fuse corresponding to the LINE VOLTAGE selector setting voltage.
For fuse replacement, disconnect the power cable and remove the fuse holder cover by rotating it counter-clockwise.

After replacement, secure the cover by rotating it clockwise.

(42) EXT BLANKING INPUT connector

Provides an input connection for an external blanking signal. The trace displayed on the CRT may be intensity-modulated, pulse signal or time-scale marks can be generated.
5V AC signal applied to the connector.

(43) (44) GATE OUTPUT connector

A: Output terminal for a positive squarewave simultaneously occuring with the A trigger sweep.
(Output: TTL level)

B: Output terminal for a positive squarewave simultaneously occuring with the B trigger sweep.
(Output: TTL level)

(45) CH1 OUTPUT connector

Makes the channel 1 input signal available for further analysis.

NOTE:
Do not use the CH1 OUTPUT when the CH1 x5 GAIN switch is pulled. The CH1 OUTPUT signal may contain noise in that mode.

6. HOW TO PRODUCE THE TRACE

Before turning ON the POWER switch, insure the AC supply voltage is within the range of 108 to 132 V for 120V AC supply, 198 to 242V for 220V AC supply, and 216 to 264V for 240V AC supply .
Connect the power cord on the rear panel to an AC outlet and set the controls as follows.

AC-GND-DC	GND
POSITION	Midrange, push in
Horizontal display mode	A
Trigger MODE	AUTO

Turn the POWER switch on and rotate the INTENSITY A & B control clockwise, and a trace appears.
Adjust the FOCUS control to obtain the sharpest trace.
When this instrument is not used, with power supplied, rotate the INTENSITY control counterclockwise to decrease the intensity. This protect the CRT from image burn.

NOTE:
For normal operation, the following function must be set in the 'CAL' position.

VAR PULL x5	Push in and rotate in the direction of arrow.
GAIN	In this case the VOLTS/DIV is calibrated to the indicated value.
PULL SWP VAR	Push in the knob or rotate in the direction of arrow. In this case the TIME/DIV is calibrated to the indicated value.

Align the trace with the horizontal graticule line at the center of the screen by operating CH1 POSITION control. In some cases, the trace may be slightly oblique to the scale by the effect of earth magnetism.
In this case, align the trace with the horizontal graticule line at the center of the screen by properly adjusting the semi-fixed variable resistor TRACE ROTATION on the front panel.

General measurement

(1) Observing a single waveform

Use Channel 1 or 2 when not observing the phase difference between two waveforms or when engaging in an operation other than X-Y operation.
Make the following settings when using Channel 1.

VERT MODE switch	CH1
A trigger MODE switch	AUTO
A trigger SOURCE switch	CH1
AC-GND-DC switch	AC or DC

Under these settings all repetitive signals higher than 30 Hz applied to Channel 1 can be triggered on and observed by adjusting the A trigger LEVEL control, with a TIME/DIV range between 2 ms/DIV and 20 ns/DIV. Since the A trigger MODE is set to the AUTO position. A trace appears even when no signal is present or when AC-GND-DC switch is in the GND position. Therefore, DC voltage measurement can be made when the switch is placed to DC. When observing low frequency signals below 30 Hz, the following switch settings are required;

A trigger MODE switch	NORM
A trigger COUPLING switch	DC

Triggering can be effected by operating the LEVEL control under this setting. When using only Channel 2, set the following switches to CH2;

VERT MODE switch:	CH2
A trigger SOURCE switch:	CH2

(2) Observing two waveforms

Observation of two waveforms can be made easily by setting the VERT MODE switch to ALT or CHOP. Set the VERT MODE switch to ALT for observation of high repetition frequency signals. While for low frequency signals, set it to CHOP. When the TIME/DIV switch is set to 1 ms or slower, select CHOP mode for flicker free observation.

ALT: 0.5 ms/DIV to 20 ns/DIV

CHOP: 1 ms/DIV to 0.5 s/DIV

To measure phase difference, trigger on the leading signal.

(3) Observing waveform in the X-Y mode

X-Y oscilloscope is available by pressing the X-Y button, in the horizontal display mode.

Input and position controls are as follows.

	Input connector	Position control
X-axis signal (Horizontal axis signal)	CH1 INPUT	CH1 POSITION
Y-axis signal (Vertical axis signal)	CH2 INPUT	CH2 POSITION

The BW LIMIT 20 MHz button must be in the released position (button off) for the X-Y operation. The LEDs for trigger do not light up in X-Y operation.

(4) Vert mode switch

In quad trace alternate mode, signlas are displayed in order of Channel 1, 2, 4, and 3.

7. METHOD FOR CONNECTING SIGNALS

The first step of measurement is to connect the signal to the oscilloscope properly. Do it with utmost care.

(1) When using a probe

Use the AT-10AL 1.5 probe, with the 10:1/1:1 selector switch set to 10:1, when measuring a high frequency signal. Since the input signal is attenuated by this probe to 1/10, this probe is not recommended for low level signals.

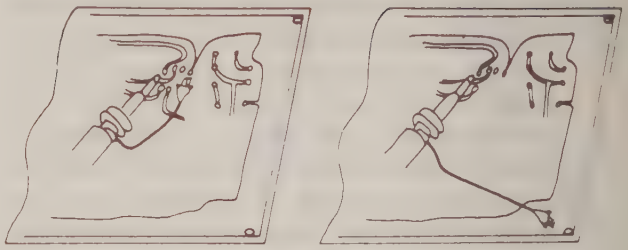
Bandwidth limitings will occur when the probe is set to 1:1. Therefore, all high frequency measurement must be made with a 10:1 selection.

<CAUTIONS>

- Do not apply a signal to the input in excess of 500V (DC + peak AC at 1 kHz).
- Connect the probe ground lead as close as possible to the point being measured especially when measuring a fast rise time or a high frequency signal. Long probe ground leads may cause waveform distortions, such as ringing and overshoot.

  For better measurements, it is recommended to be use the standard ground lead attachment be used with the AT-10AL 1.5 probe.

Connection of ground lead



(a) Proper (b) Improper

- Multiply the reading of VOLTS/DIV by 10.
  For example, if the VOLTS/DIV switch is set to 50 mV/DIV, then read the waveform as
  50 mV/DIV x 10 = 500 mV/DIV
- To avoid measurement error, probe calibration must be done especially when probes are changed on the instrument. Connect the probe tip to the CAL output terminal and the probe tip to the GND terminal. A 1 kHz square wave should be displayed with flat tops. Any distortion in the presentation is caused by incorrect probe compensation. If overshoot or undershoot is present, turn the screwdriver adjustment in the probe for a flat-top presentation.

(a) Optimum (b) Capacity too small (c) Capacity too large

(2) Direct input connection

When connecting a signal directly to the oscilloscope not using an AT-10AL 1.5 probe, pay attention to the following points in order to minimize measurement error.

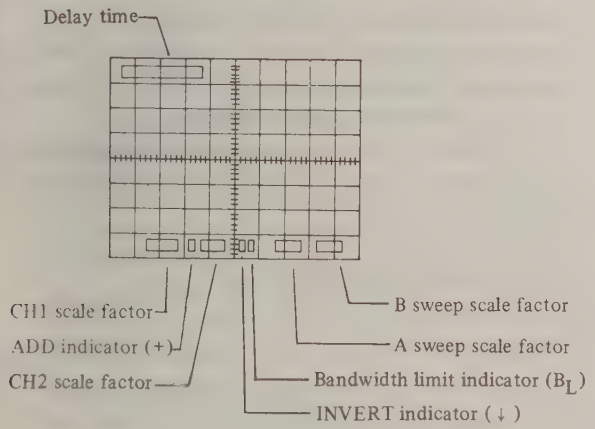
- When performing observations using a bare lead wire, no trouble occurs when the circuit to be measured is of low impedance and high level.
  However, measurement error may be caused by stray coupling with other circuits and power line.
  This measurement error cannot be ignored even in low frequency regions.
  In general, avoid measuring with non-shielded wire. When using a shielded wire, connect one end of the shield to the ground terminal of the oscilloscope and the other end to the ground of the circuit to be measured. It is desirable to use a coaxial cable with a BNC type connector.
  The following cautions must be observed when performing a wide bandwidth measurement. It is necessary to terminate the cable with a characteristic impedance, when measuring a rapidly rising waveform or a high frequency wave.
  The absence of a termination resistor will necessarily lead to a measurement error derived from ringing phenomenon in long cable. Some measuring circuits require a termination resistor equal to the characteristic impedance of the cable also be applied at the measurement point.
  A BNC type termination resistor (50 Ω) is conveniently used for this purpose.
- In order to perform measurements with the circuit put it in a proper operating state, it is sometimes necessary to terminate the cable with an impedance which corresponds to the circuit being measured.
- The stray capacity of the shield wire must be taken into account when performing measurements with a long shield.
  Since the shield wire normally in use has a capacity of about 100 pF per meter, its effect on the circuit to be measured cannot be ignored.
  Use a x10 probe to minimize the effect on the circuit.
- When the length of the shield wire used or when the length of the non-terminated cable reaches 1/4 the wave length or its multiples within the band of the V-1100 (1/4 the wave length is about 0.5 meter when using a coaxial cable at 100 MHz), oscillation may be caused near 5 mV/DIV range.
  This is caused by the reasonance between the externally

connected high-Q inductance and the input capacity. Reduce the Q by connecting the cable or shield wire to the input connector by the resistors connected in series, or by performing measurements at another VOLTS/DIV range.

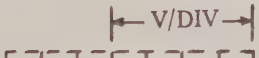
8. MEASURING PROCEDURES

(1) Readout function

(a) Display allocation on the CRT



(i) Scale factor format of CH1 and CH2

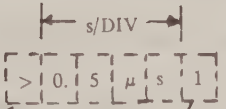


Probe indicator
10X probe: P_{10X}
1X probe
or other: (Blank)
(Refer to item 8-(1)-(b))

GND: ⏚
UNCAL: >
X5 MAG: *
X1 CAL: (Blank)

AC: V̄
DC: V
GND: V

(ii) Scale factor format of A and B′ sweeps



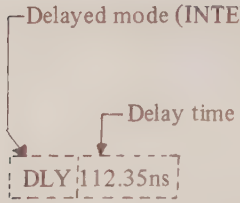
X1: (Blank)
X10 MAG: *
UNCAL: > (A only)

Trigger source

CH1: 1
CH2: 2
CH3: 3
CH4: 4
LINE: L_N
ALT: 1_2

(A only)

(iii) Delay time



(a) The units becomes 'DIV' in the uncalibrated sweep rate.
(b) A mark greater than '>' is displayed on the left of numerals in the NORM of B trigger MODE.
(c) When the A sweep rate is faster than B, the warning 'DLY A<B' is displayed.

(b) How to apply various attenuation of the probe.

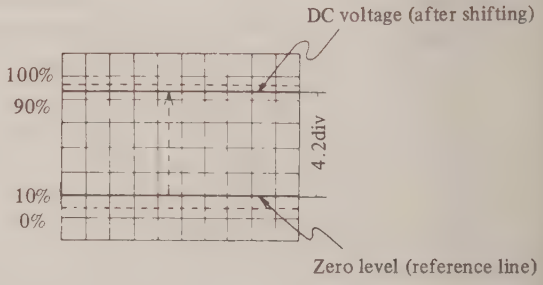
Turn DLY POS control to the right (+) or left (-) when pressing the RESET button. For instance, when changing the scale factor from x1 to x10 at 10 mV/DIV range, turn DLY POS control to the right (+) while pressing RESET button. Then, the readout is changed from '10 mV/DIV' to '0.1V/DIV' and a multiplication mark 'P10x' is displayed. When changing from x10 to x1, turn DLY POS control to the left (-) while pressing the RESET button.

Then, the readout will be changed from '0.1 V/DIV' to '10 mV/DIV' and a multiplication mark 'P_{10x}' will disappear.

(2) Basic triggering method.

Set the horizontal display mode switch to A. The V-1070 will automatically set the A mode trigger.
When the display mode switch is set to ALT, INTEN or B, A/B trigger switch alternately selects A mode trigger (main sweep) or B mode trigger (delayed sweep).
The condition being selected by MODE, SOURCE, and COUPLING is applied to either A or B the indicated mode trigger.

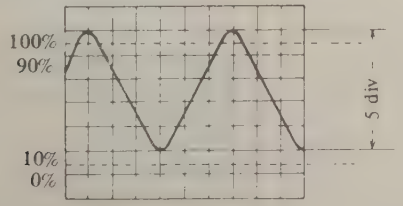
(3) DC voltage measurement



Set the AC-GND-DC switch to GND and obtain the baseline trace. Set the AC-GND-DC switch to DC and set the VOLTS/DIV switch to obtain an optimum amplitude waveform. Since the trace shifts by the amount of DC voltage, the DC voltage of the signal can be obtained by multiplying the shift by the indicated value of VOLTS/DIV. When VOLTS/DIV is 50 mV/DIV, then 50 mV/DIV x 4.2 = 210 mV (However, if a 10 x probe is in use, the true value of the signal becomes 10 times the value, it will be 50 mV/DIV x 4.2 x 10 = 2.1V.)

(4) AC voltage measurement

The measuring method is same as [3] – (a) "DC voltage measurement", but there is no need of matching the zero level with the scale line. Position the baseline trace for easy observation. When magnifying a small-amplitude signal superimposed on a high DC voltage, set the AC-GND-DC switch to AC. The DC component will be blocked, therefore it is possible to increase the sensitivity. When one division represents 1 Vp-p, five divisions equal to 5 Vp-p.



(5) Frequency and period measurement

The below illustration shows one period of time between A and B, which represents 2.0 DIV.

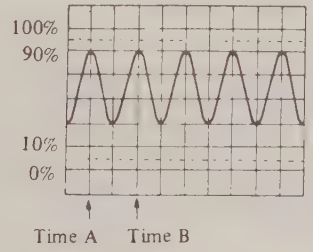
When the sweep time is 1 ms/DIV, the period is given by

$1\ \text{ms/DIV} \times 2.0 = 2.0\ \text{ms}$

$= 2.0 \times 10^{-3}\text{s}$

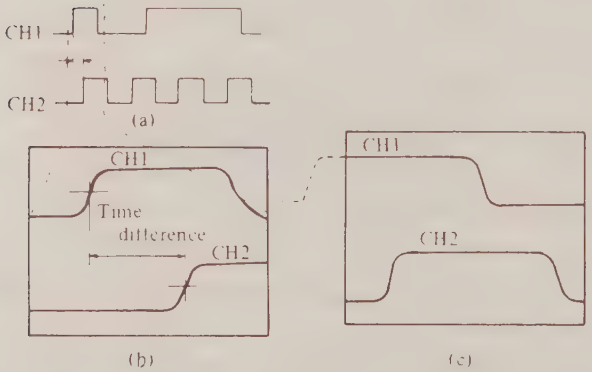
Accordingly, the frequency is

$1/(2.0 \times 10^{-3}) = 500\ \text{Hz}$

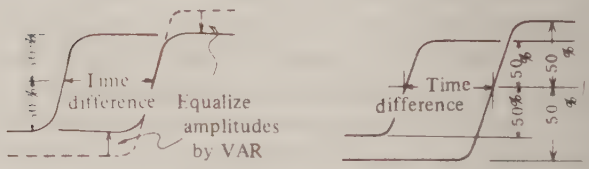


(6) Time difference measurement

Select a "SOURCE" for the reference signal when measuring the time difference between two signals. Assume a pair of pulse trains are displayed as shown in (a), with CH1 selected as the trigger source. A signal delay appears



between CH1 and CH2 (b). The delay time is measured between the 50% amplitude points on both pulse leading edges. Accuracy of the reading will be based on the amplitude displayed for each pulse train. Therefore, the attenuators for CH1 and CH2 should be set to the same voltage settings. Care should be taken in selecting the trigger source since one signal may be shifted off the screen (c).



<CAUTIONS>

Proper circuit termination is required since high frequency components of the square wave are present. Therefore, use of correct probe or coaxial cable is necessary, with the ground lead kept as short as possible.

(7) **Rise time and fall time measurement**

To measure the rise time, attention must be observed to measurement error. The following relationship exists among the rise time Trx of the waveform to be measured, the rise time Trs of oscilloscope, and the rise time Tro displayed on the screen.

$$Trx^2 + Trs^2 = Tro^2$$

When the rise time of the pulse going to be measured is sufficiently longer than the rise time of the oscilloscope (less than 3.5ns in our case), measurement error caused by the rise time of the oscilloscope can be neglected. However, if both are close each other, measurement error may be caused.
The true rise time is given by

$$Trx = \sqrt{Tro^2 - Trs^2}$$

In a circuit free from waveform distortion such as overshoot and sag, the following relationship is established between the frequency band and the rise time.

$$fc \times tr = 0.35$$

where, fc : Frequency band (Hz)
tr : Rise time (s)

The rise time and fall time are determined by the time elapsed between the 10% to 90% values of pulse width.

(8) **Single-shot signal measurement**

Single sweep is conveniently used in signal photography and waveform measurements of irregular repetition (such as impulse waves, sound waves, switching noise).
Before operation the single-shot measurement, make a test measurement before a desired measurement is taken, as described below.
(Test measurement)

Select the NORM mode for the A trigger MODE. Apply an equivalent signal to a channel, and trigger it by rotating the LEVEL control. Then change to the SGL mode. After the READY indicator goes off, press the RESET button.

After confirmation of a single sweep, take the desired measurement.

(Desired measurement)

Remove the vertical axis input signal by setting the AC-GND-DC switch to GND. Press the RESET button and confirm that the READY indicator lights up.

Apply the signal to be observed. After the single sweep, the READY indicator goes off.

Since single sweep operates by changing the trigger level, even if no signal aplies, do not rotate the trigger LEVEL control once test measurement is ready.

(9) Triggering method

(a) Alternate triggering

Continue to depress the SOURCE lever when the VERT MODE is ALT.

Both indicators for CH1 and CH2 will light up after indicating the LINE. Then the alternate triggering mode is obtained.

When both signals of Channels 1 and 2 which are out of sync, a stabilized alternate waveform is obtained in the alternate triggering mode.

NOTE:

Trigger coupling is automatically set to the DC mode in the alternate triggering mode.

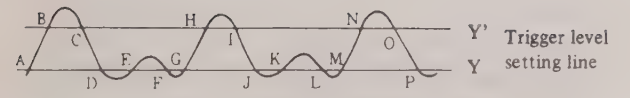
When the VERT MODE setting is changed from the ALT mode to the other modes, the trigger source is automatically set as follows.

VERT MODE	SOURCE
ALT → CH1	CH1
ALT → CH2	CH2
ALT → CHOP	CH1
ALT → ADD	CH1

(b) Triggering of complexed waveform

In the case shown in Fig. (a) where waveforms greatly different in amplitude, the waveform is doubled if the trigger level is not set properly. In the case where the trigger level is selected by line Y, two wave will appear, one starting with A and advancing to B, C, D, E, F, ... and the other starting with E and advancing to F, G, H, I . . . . ., will appear alternately on the screen. They will be doubled as shown in Fig. (b), for which no triggering can be taken.

In such a case, rotate the LEVEL control clockwise until the trigger level comes to Y' line. Then the waveform on the screen becomes the one as shown in Fig. (c) which starts with B and advances to C, E, F, ... and allows synchronization.



(a) Signal waveform

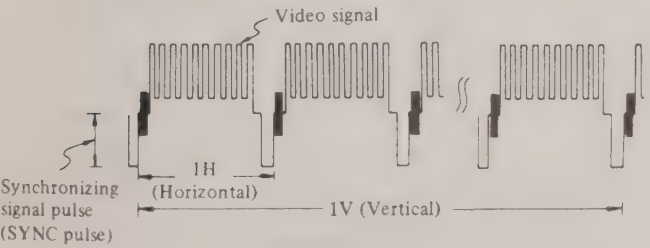
(b) When the trigger setting level is Y

(c) When the trigger setting level is Y'

Synchronization of complexed waveform

(c) TV trigger

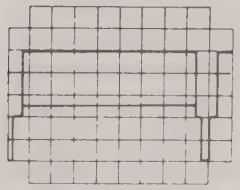
① On the image waveform of TV



In video work complexed signals containing video signal and sync signal are often measured.

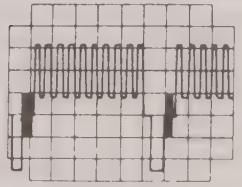
② Operation

To observe vertical signal



TRIG MODE: TV-V

To observe horizontal signal



TRIG MODE: TV-H

(NOTE) This oscilloscope synchronizes with only (-) synchronizing signal.

Since the sync pulse of video signal is generally (-), SLOPE is automatically set to (-) by setting COUPLING to TV-V or TV-H.
Trigger level operation is not required in the TV mode.

NOTE:
TV mode auto-triggering is not available for (+) sync whose video signal is inverted.

(10) Operating procedure of delayed sweep

Delayed sweep is used to magnify and observe any protion of a complexed waveform in the horizontal direction. There are two kinds of delay sweeps, one is AUTO delay sweep (continuous delay sweep) and the other NORM delay sweep (triggering delay sweep). These are selected by the B trigger MODE switch. Usually, the instrument is used in AUTO mode.

Although the AUTO delay sweep is easy to operate, the maximum magnification factor is limited to a few hundred times by delay jitter. On the other hand, since no jitter is generated in NORM delay sweep, this sweep has the feature to increase the magnification factor. The magnification factor is limited by the brightness of CRT to a few thousand times.

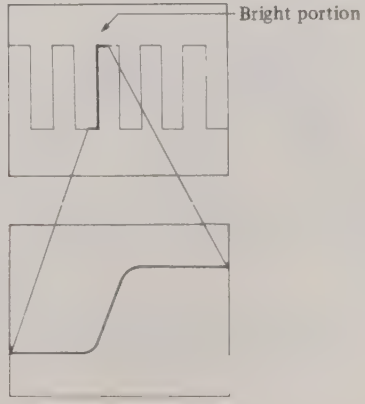
(a) AUTO (Continuous delay sweep)

Effect triggering by A sweep and set the switches as follows.

Horizontal display mode	: ALT (or INTEN)
A TIME/DIV	: As desired
B TIME/DIV	: Set B TIME/DIV at a faster sweep time than the one set by A TIME/DIV
A/B	: B
B TRIG MODE	: AUTO

The high brightness portion of A sweep will appear (if not, adjust INTENSITY △ B).

Turn the DLY POS control, and the high brightness portion will move continuously. Push and turn of the DLY POS control moves if faster. Bring this high brightness portion to the position desired to be magnified. Then, the high brightness portion is magnified to occupy the full area of the screen. (When the horizontal display mode is set to INTEN, it is required to change the mode from INTEN to B.)



The time from a starting point of A sweep to that of the brightness portion is displayed on the upper side of the CRT. The sweep time is given by the B TIME/DIV.

NOTE:

The LEDs of SOURCE and COUPLING for B trigger do not come on in the AUTO mode of B trigger, since the SOURCE and COUPLING are of no effect.

In the AUTO mode of B trigger, the startpoint of B sweep is set by the DLY POS control.

(b) NORM (Triggering delay sweep)

Effect triggering by A sweep and set the controls as follows.

Horizontal display mode	: ALT (or INTEN)
A TIME/DIV	: As desired
B TIME/DIV	: Set B TIME/DIV at a faster sweep time than the one set by A TIME/DIV
A/B	: B
B TRIGGER MODE	: NORM
SLOPE	: Select (+) or (-) by the SLOPE switch.

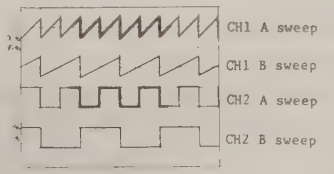
Rotate the B trigger LEVEL control, the high brightness portion of A sweep appears. (This state is called the B-triggered state.) Rotate the DLY POS control, the high brightness portion moves to the next peak. Bring this high brightness portion to the position desired to be magnified by using DLY POS control and B trigger LEVEL. Then the high brightness portion is magnified to occupy the full area of the screen. (When the display mode is set to INTEN, it is required to change the mode from INTEN to B.)

The sweep time is given by the B TIME/DIV. In the NORM mode, a mark greater than '>' is displayed or the left side of the delay time numerals.

(c) ALT sweep

The ALT sweep function alternately displays main sweep (A) and delayed sweep (B) on the CRT.

The below figure shows the display in the ALT sweep mode.



A sawtooth waveform is applied to Channel 1 and a square waveform to Channel 2 in this case.
The B sweep trace can be moved up to about four divisions above the A sweep trace for the convenience of observation by the A/B SWP SEP control. By pressing the QUAD button in the ALT sweep mode, four more traces, eight traces in total, appear on the CRT. The later four traces are A and B sweeps of Channels 3 and 4.

NOTE:
Since traces are alternately displayed in the ALT sweep mode, flicker can occur in the slow sweep rate.
To avoid this, set the TIME/DIV switch to the 0.2 ms/DIV or higher.

(d) Delay sweep in TV mode

i) In the TV-V mode for the A trigger COUPLING, the B trigger COUPLING is automatically set to TV-H.
The B COUPLING cannot be set to TV-H independent of A trigger.

ii) In the TV-H mode of A trigger, the B trigger MODE is automatically set to AUTO.

(11) Initial setting

In case of abnormal AC power or something the microprocessor built in the oscilloscope can malfunction pulling the DLY POS (PULL INITIAL SET) control out makes the microprocessor initial set condition or turning Power switch off and on will restore operation.

9. SPECIFICATIONS

CRT

Configuration and useful screen	6-inch rectangular screen with internal graticule; 8 x 10 DIV (1 DIV = 1 cm), marking for measurement of rise time.
Accelerating potential	18 kV
External intensity modulation	DC to 3.5 MHz, maximum input voltage 20V (DC + peak AC)
Trace rotation	Present
Scale illumination	Variable

VERTICAL DEFLECTION

Sensitivity	<CH1 and CH2> 5 mV to 5 V/DIV In 10 calibrated steps ±2% (at +10 to 35°C), x 5 1 mV/DIV, 2 mV/DIV ±4%, continuous variable control between steps at least 1:2.5 (with UNCAL displayed) <CH3 and CH4> 0.1 V/DIV, 0.5 V/DIV ±2% (at +10°C to 35°C)
Bandwidth	<CH1 and CH2> DC to 100 MHz (-3 dB) reference 8 division (bandwidth may be limited to 20 MHz by bandwidth limit switch) DC to 15 MHz (-3 dB) reference 8 division at 5 x magnification. <CH3 and CH4> DC to 100 MHz (-3 dB), reference 8 division
Rise time	3.5 ns, 24 ns at x5 magnification
Delay line	Permits viewing leading edge of displayed waveform.
Input coupling	<CH1 and CH2> AC-GND-DC, <CH3 and CH4> AC-DC
Input impedance	Direct: 1 MΩ approx. 28 pF using probe: 10 MΩ, approx. 12 pF

Maximum input voltage	400 V (DC + peak AC at 1 kHz)
Display modes	CH1, CH2, (normal or invert) ALT, CHOP (approx. 250 kHz), ADD, QUAD
Quad mode	Permits positioning independently
Polarity switching	+ or - (CH2 only)
X-Y operation	CH1: X axis, CH2: Y axis, Sensitivity: 5 mV/div to 5 V/div (1 mV/div at x5 magnification bandwidth: DC to 2 MHz (-3 dB), phase error 3° or less from DC to 1 MHz.
Dynamic range	8 DIV or more
Common-mode rejection ratio	At least 20 dB at 20 MHz

- **HORIZONTAL DEFLECTION**

Time Base A	20 ns/div to 0.5 s/div in 23 calibrated steps, 1-2-5 sequence. x10 magnifier fastest sweep rate to 2 ns/DIV. Uncalibrated continuous control between steps 1: <2.5.
Time base B	20 ns/div to 50 ms/div in 20 calibrated steps, 1-2-5 sequence. x10 magnifier fastest sweep rate to 2 ns/DIV.
Accuracy	±2% or less (at +10°C to 35°C). Additional error for magnifier ±2%
Display modes	A only, Alternate, A intensified by B, B Delayed
Delay time jitter	Better than 1:20,000

- **TRIGGER A AND B**

A trigger modes	Automatic, Normal (For signals below 30 Hz), Single sweep, TV-V, TV-H
A trigger source	A : CH1, CH2, CH3, CH4, ALT (CH1, CH2), LINE
A trigger sensitivity	

	DC to 20 MHz	20 MHz to 100 MHz
CH1 and CH2	0.3 div	1.5 div
CH3 and CH4	0.5 div	1.5 div

A trigger coupling	AC, HF Rej, LF Rej, DC
A trigger slope	+ or -
A trigger variable holdoff	Adjustable control permits a stable triggering of repetitive complex waveform
B trigger modes	Automatic, Normal (CH1, CH2, CH3, and CH4)
B trigger source	CH1, CH2, CH3, CH4
B trigger couple	AC, DC
B trigger slope	+ or -
TV trigger	(-) sync pulse more than 1 div

READOUT FUNCTION

Panel setting displays	Vertical axis : V/DIV (CH1 and CH2 only), INVERT, ADD, BW LIMIT 20 MHz, UNCAL, MAG (converted value), Input coupling (CH1 and CH2 only) Sweep rate : S/DIV, UNCAL, MAG (converted value) Others : Delay time, Trigger source

CALIBRATER 0.5 V ±1%, Frequency 1 kHz ±0.1% square wave

OUTPUT SIGNALS

Gate signal output	TTL positive gate pulse from A and B
CH1 output	25 mV/DIV terminated into 50 ohm DC to 100 MHz (-3 dB)

POWER SUPPLY

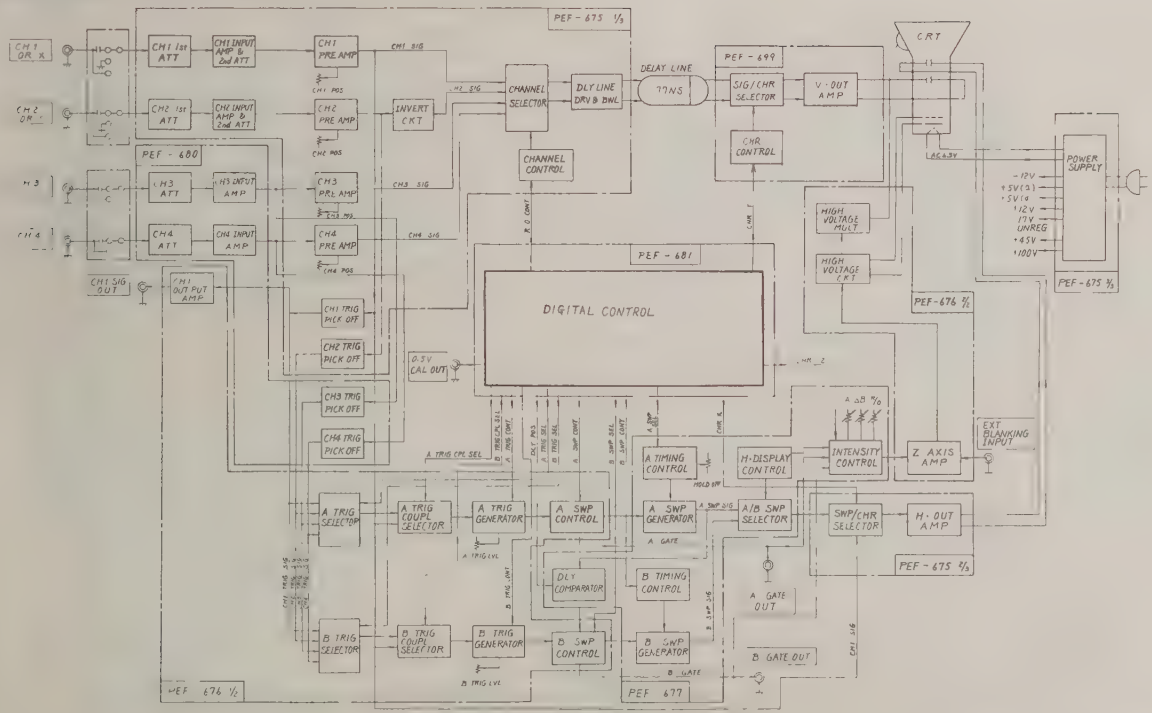
Voltage	100/120/220/240V ±10%
Frequency	48 – 440 Hz
Power consumption	Approx. 65W

OUTER DIMENSIONS Approx. 330 (W) x 160 (H) x 410 (D)

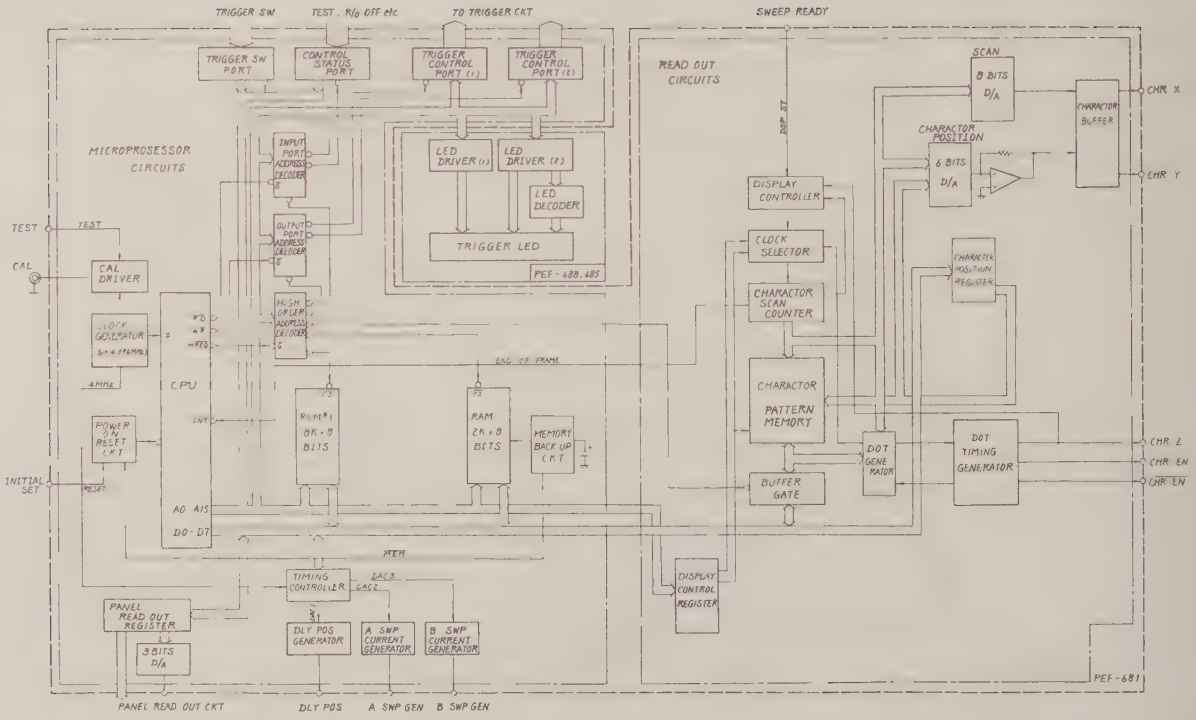
- **WEIGHT** Approx. 10 kg
- **ENVIRONMENT**

Temperature	Specification	+10°C to 35°C
	Operating	-10°C to 50°C
	Storage	-20°C to 70°C
Humidity	Operating	35% to 85%

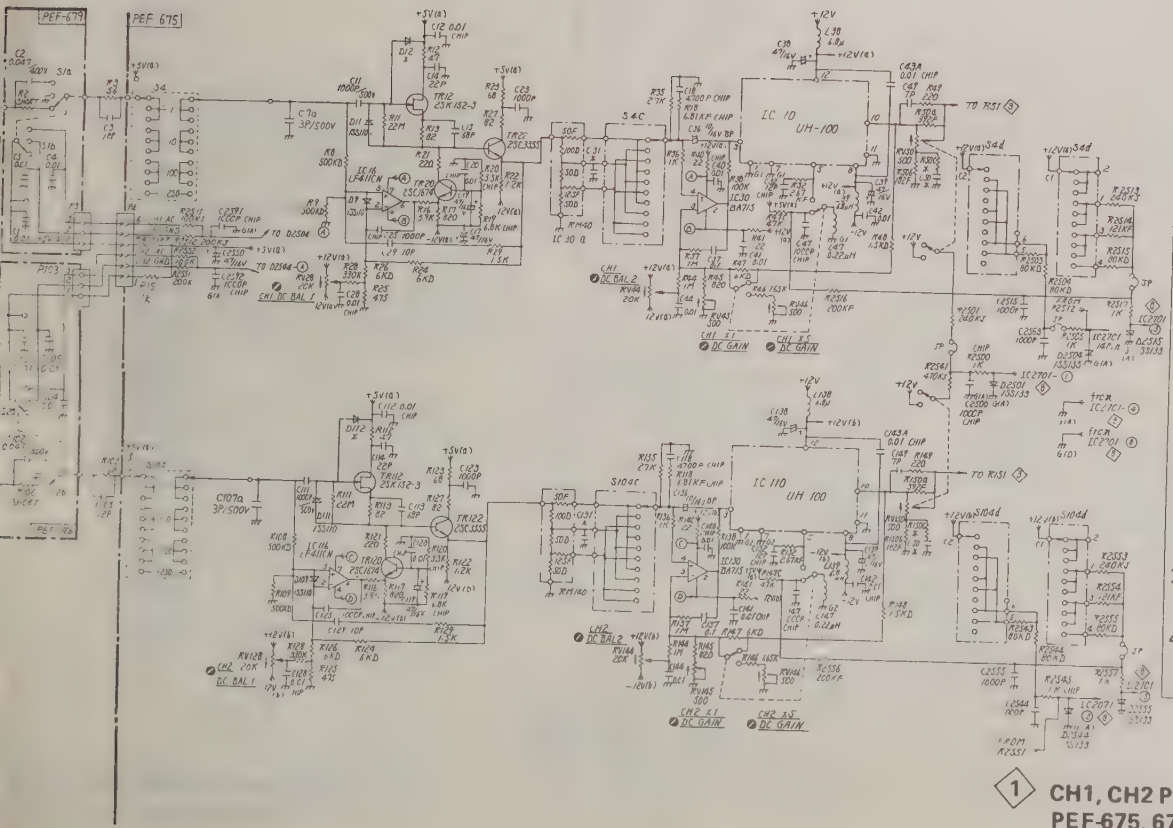
10. SCHEMATIC DIAGRAMS



BLOCK DIAGRAM (OSCILLOSCOPE)



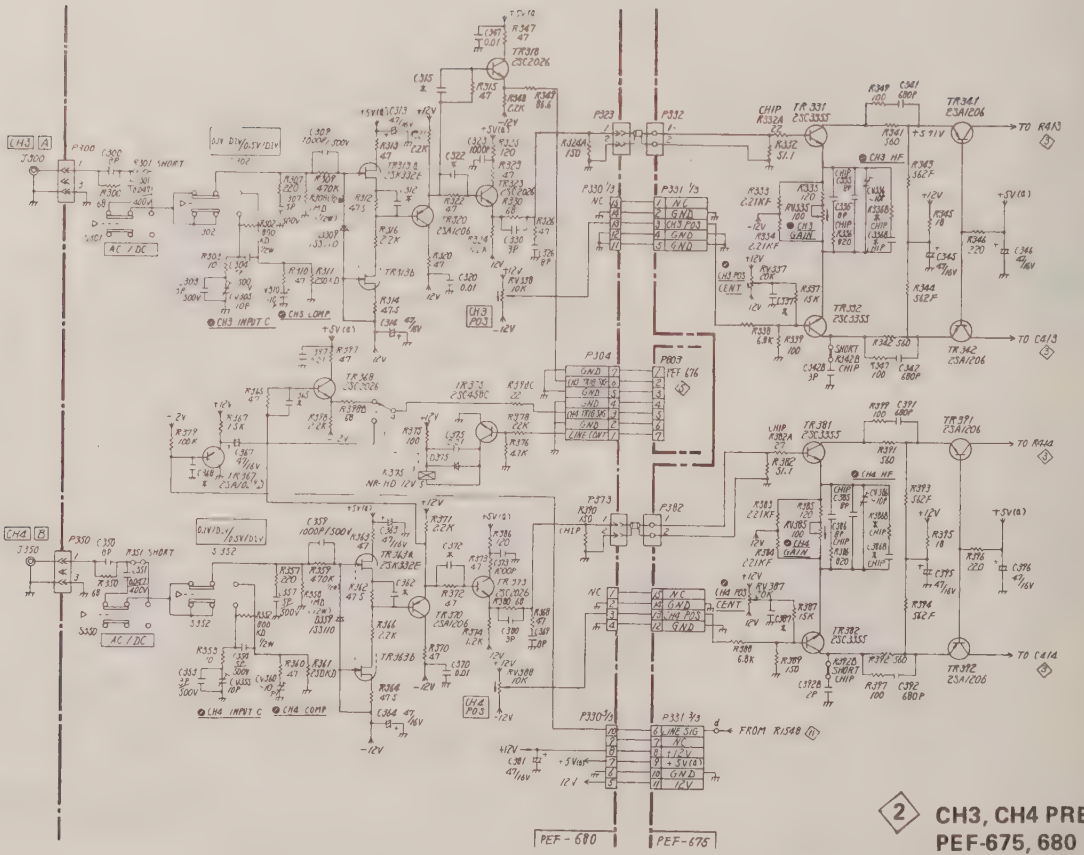
BLOCK DIAGRAM (DIGITAL CONTROL



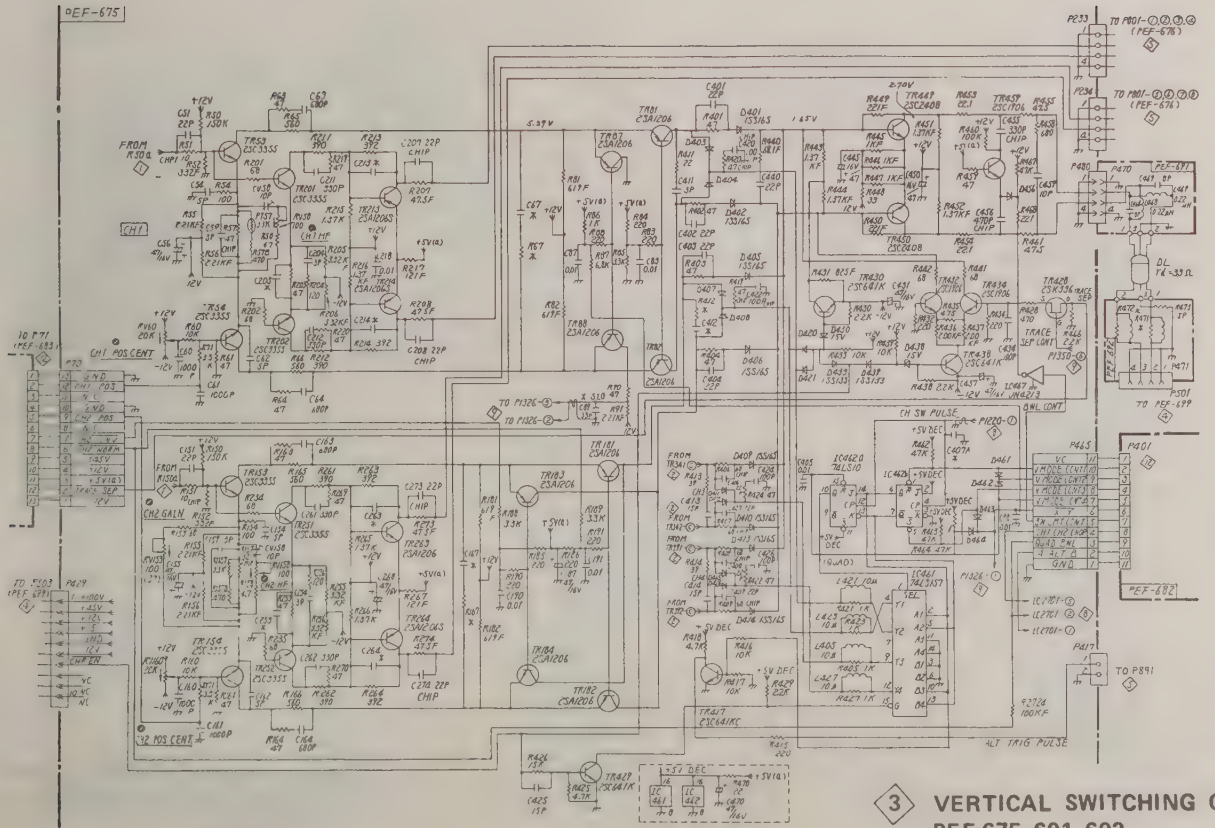
Notes:

1. All of the basic circuit diagrams are subjects to change without notice.
2. All resister values in ohm: 1/4W and all capacitor values in micro farad unless indicated.
3. *: Factory selected values.
4. Diode: 1SS133 unless otherwise noted.

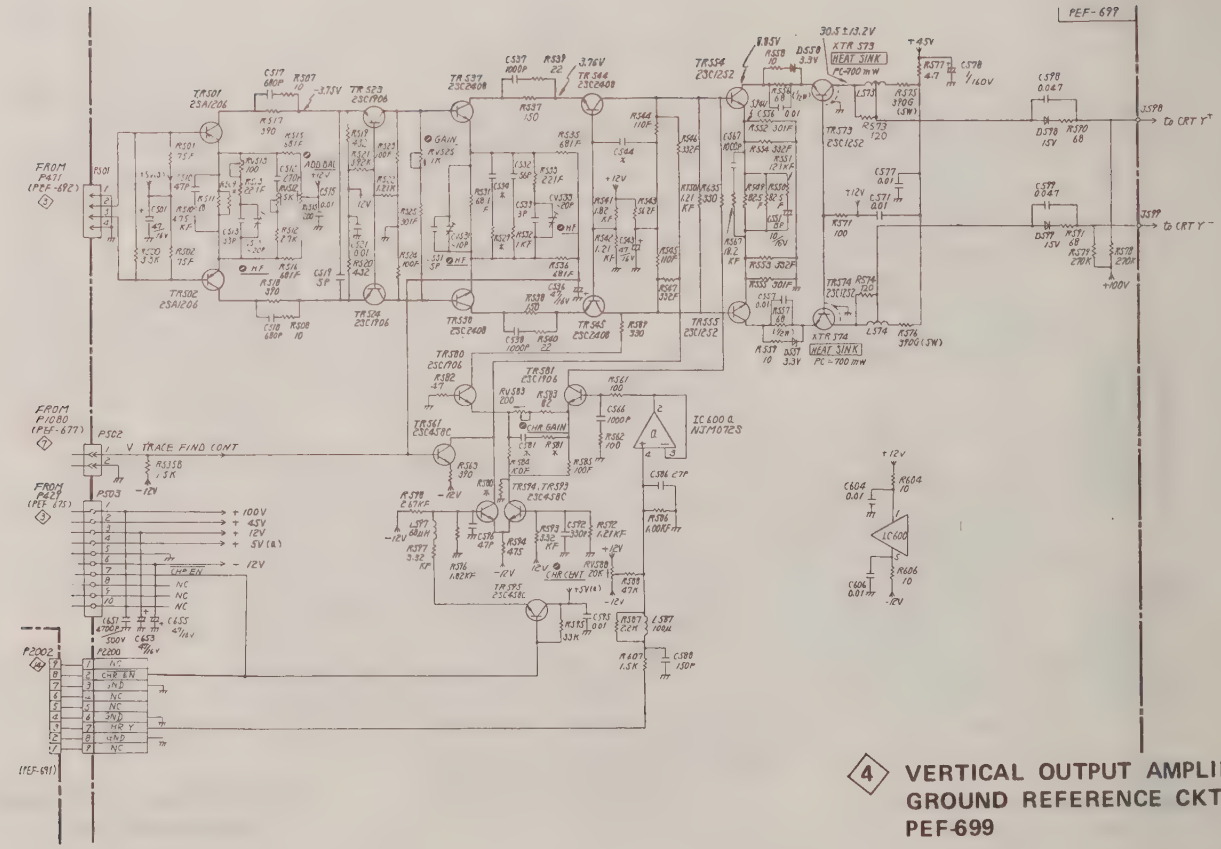
(1) CH1, CH2 PREAMPLIFIER PEF-675, 679, 696, 706



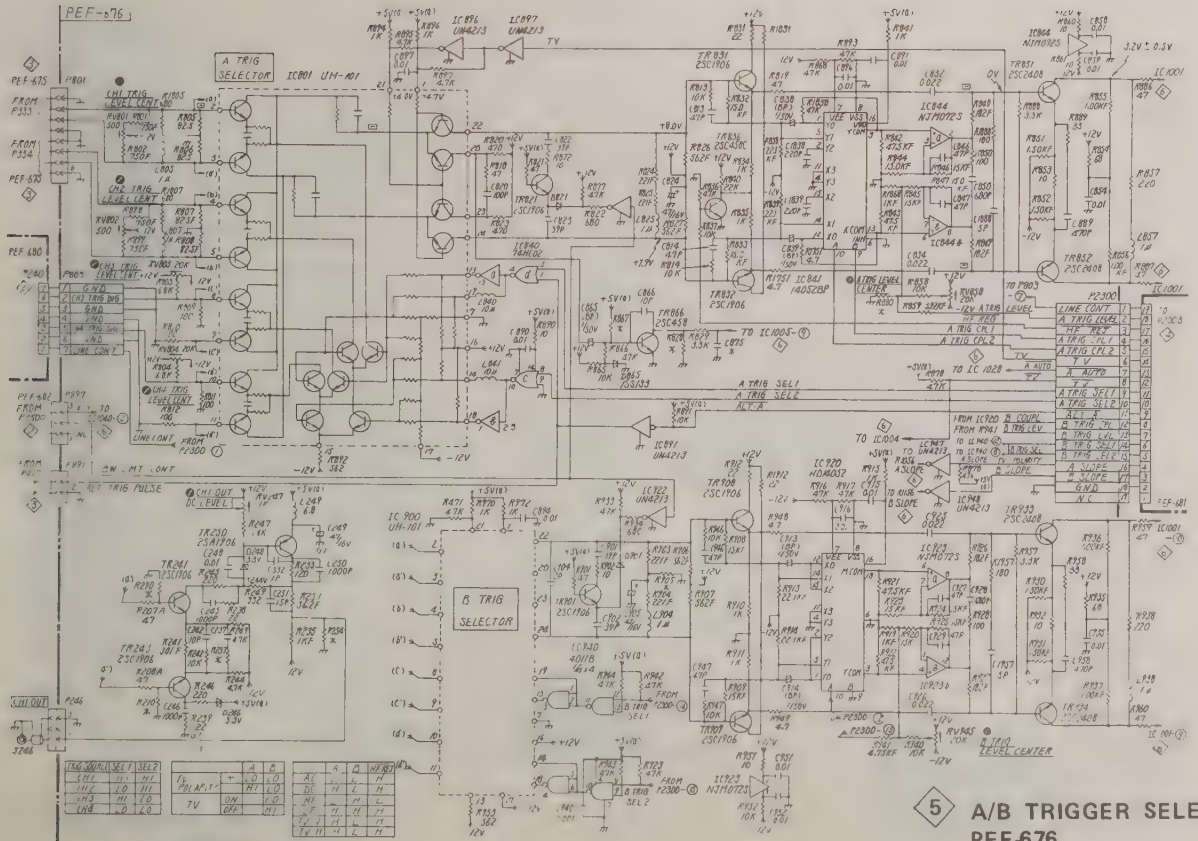
2 CH3, CH4 PREAMPLIFIER
PEF-675, 680



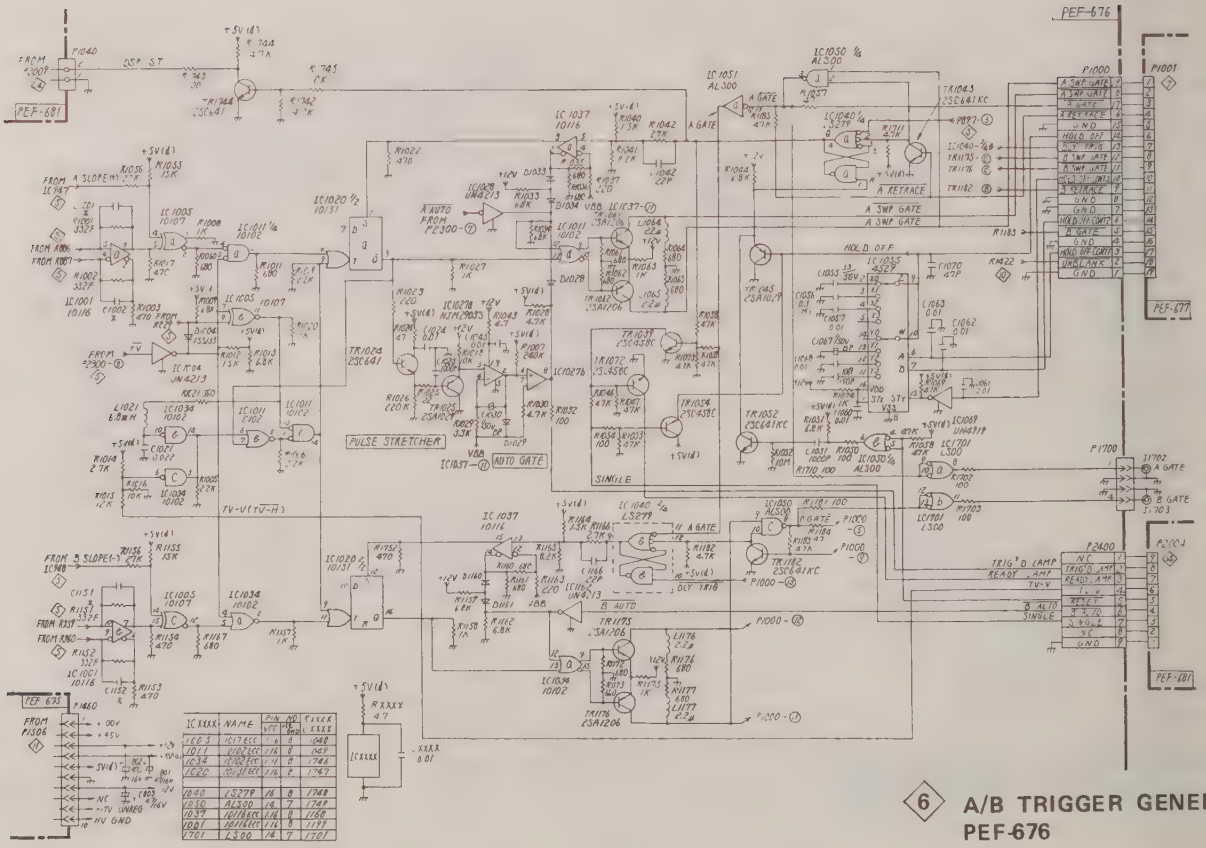
3 VERTICAL SWITCHING CKT
PEF-675, 691, 692



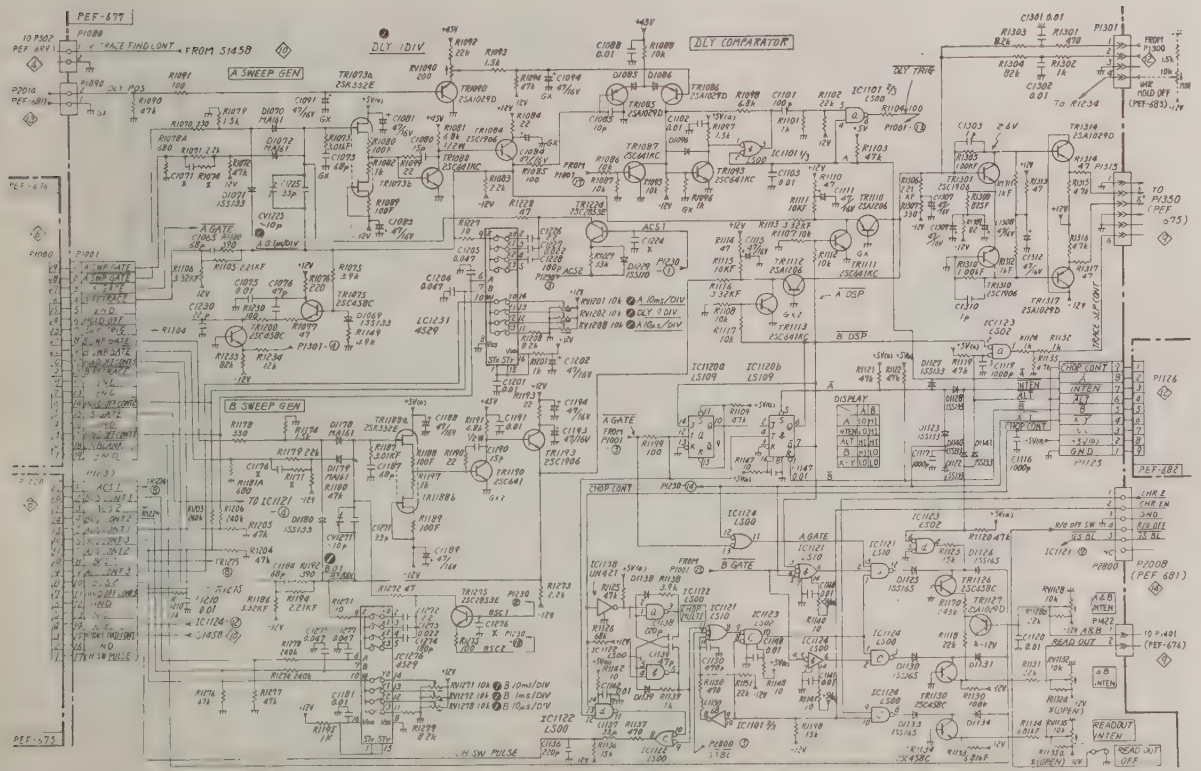
4 VERTICAL OUTPUT AMPLIFIER GROUND REFERENCE CKT PEF-699



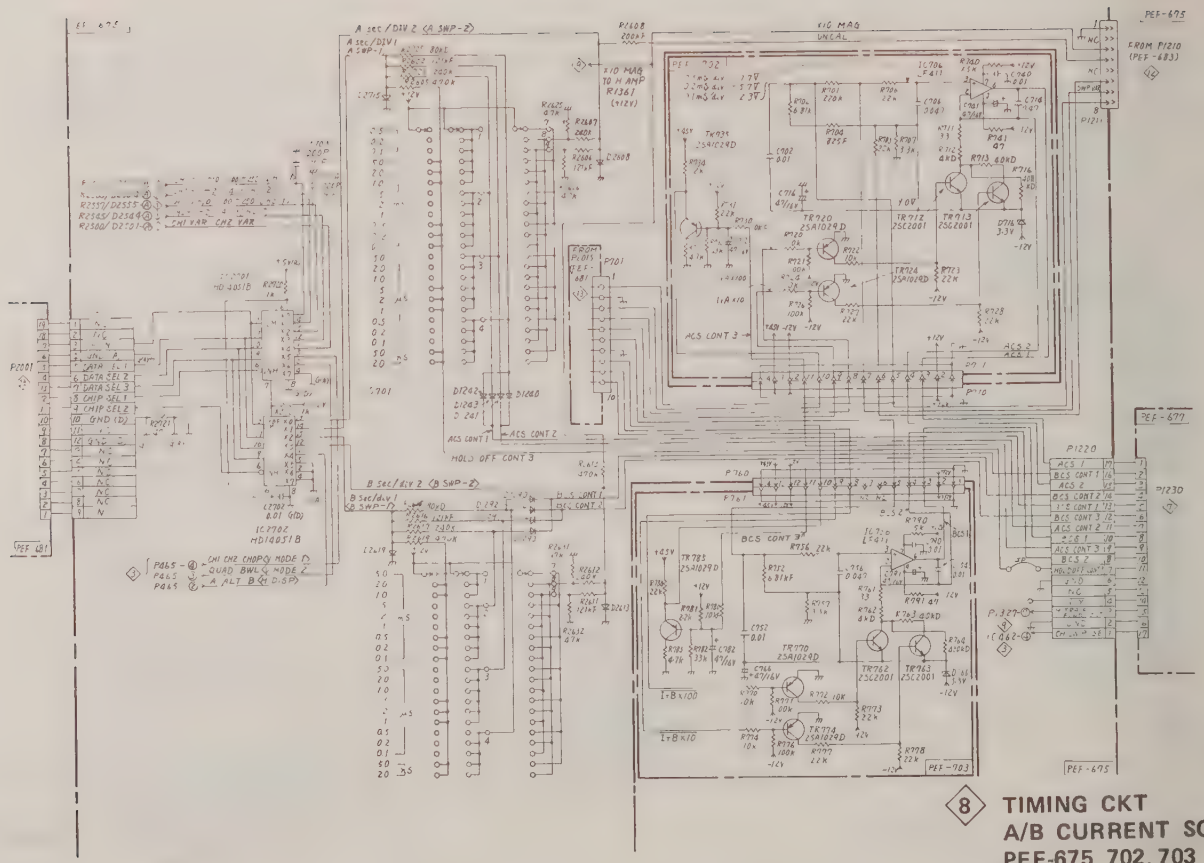
5 A/B TRIGGER SELECTOR
PEF-676



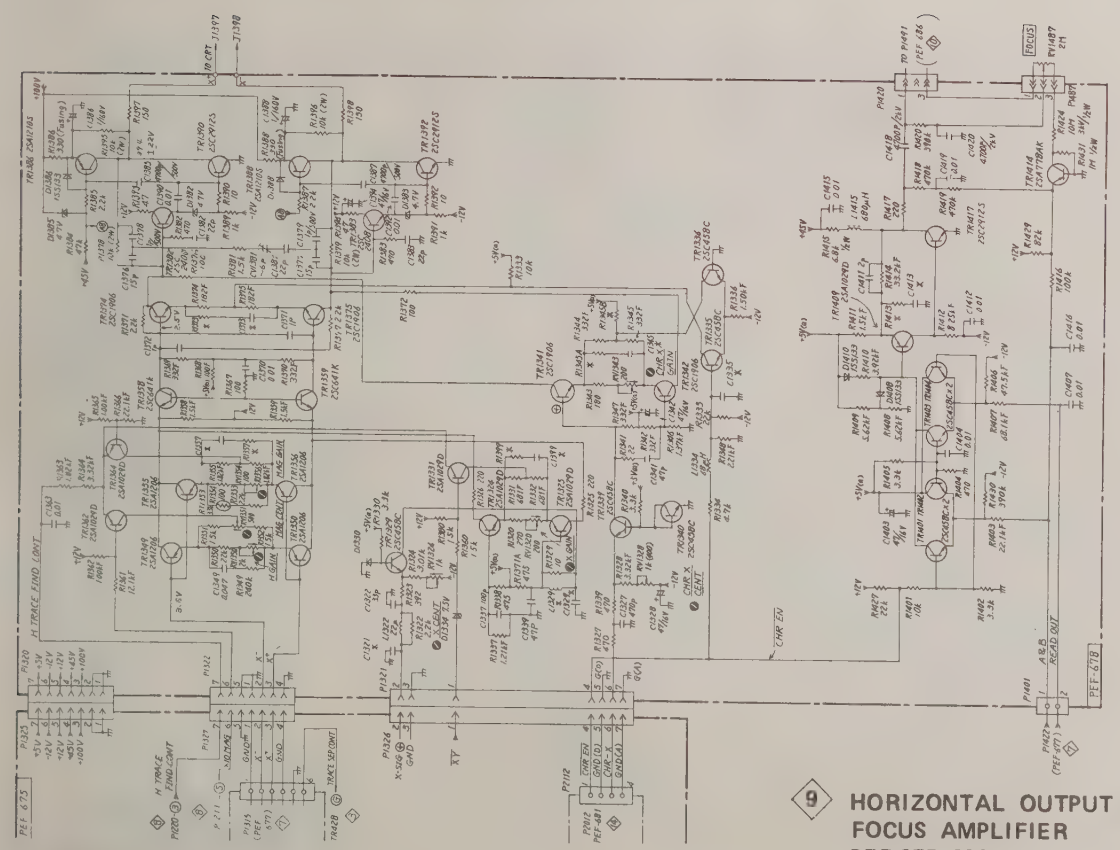
6 A/B TRIGGER GENERATOR
PEF-676



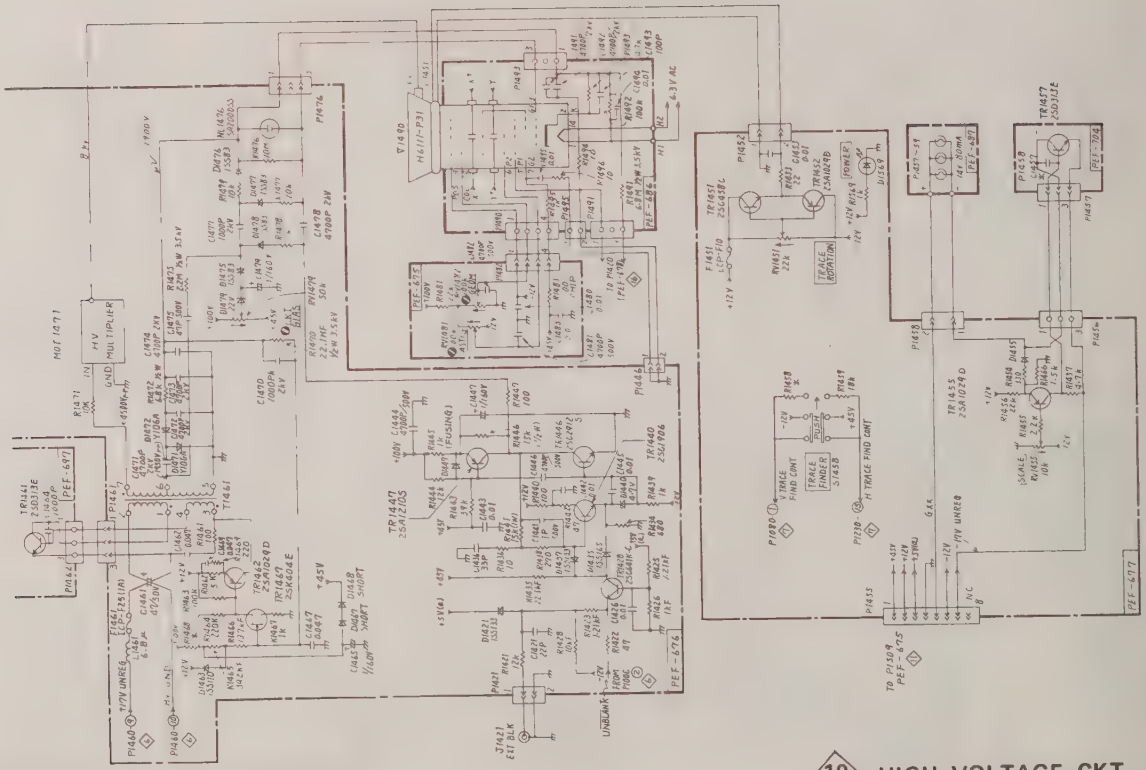
7 A/B SWEEP GENERATOR
PEF-677



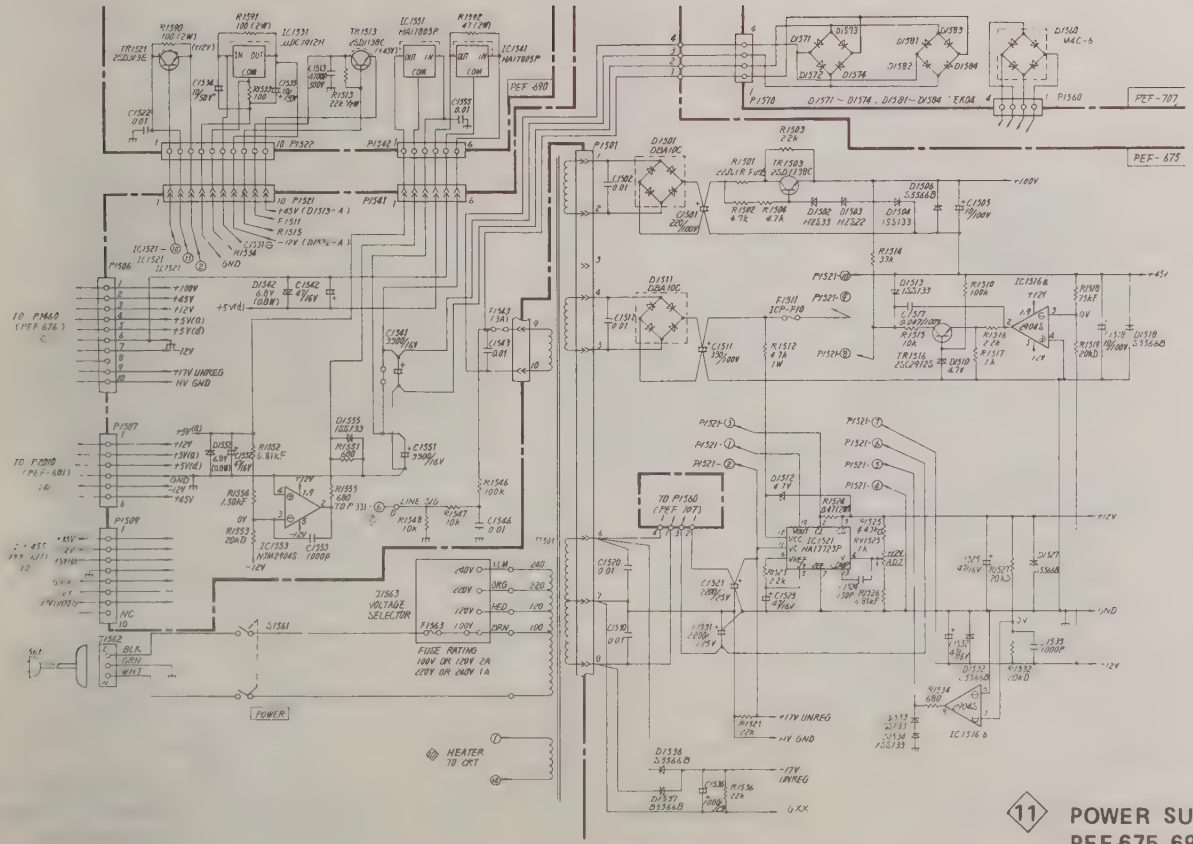
8 TIMING CKT
A/B CURRENT SOURCE
PEF-675, 702, 703



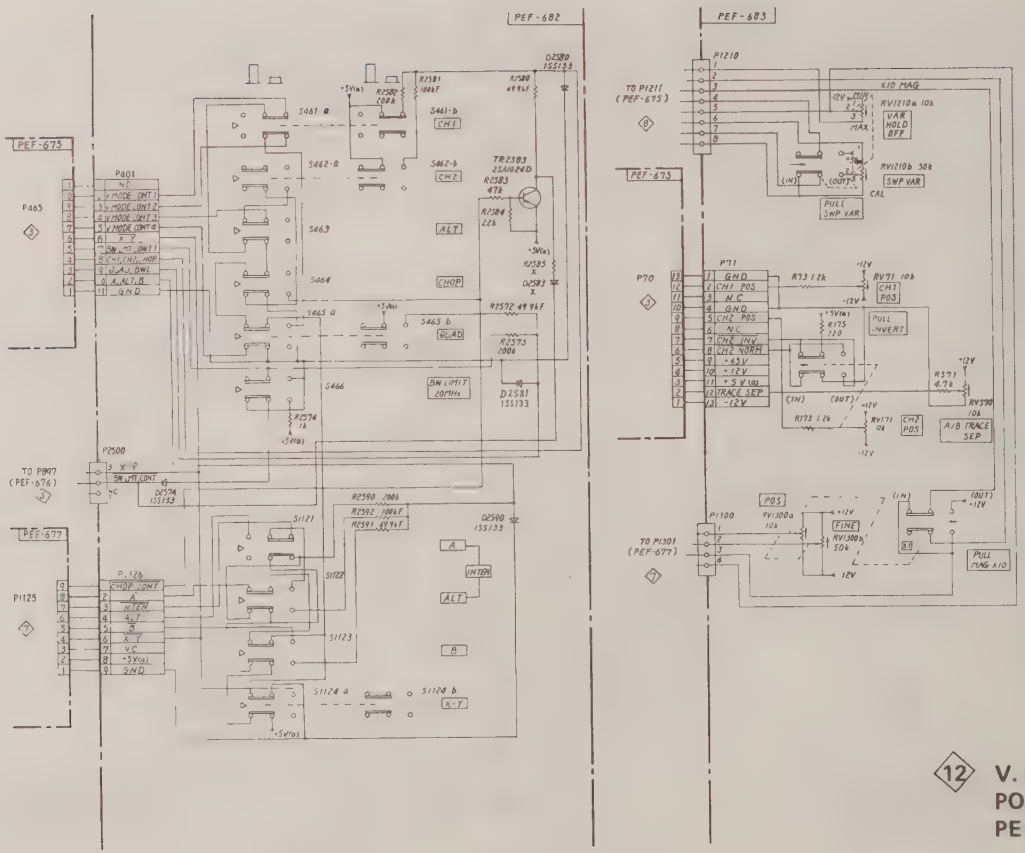
9 HORIZONTAL OUTPUT AMPLIFIER
FOCUS AMPLIFIER
PEF-675, 678



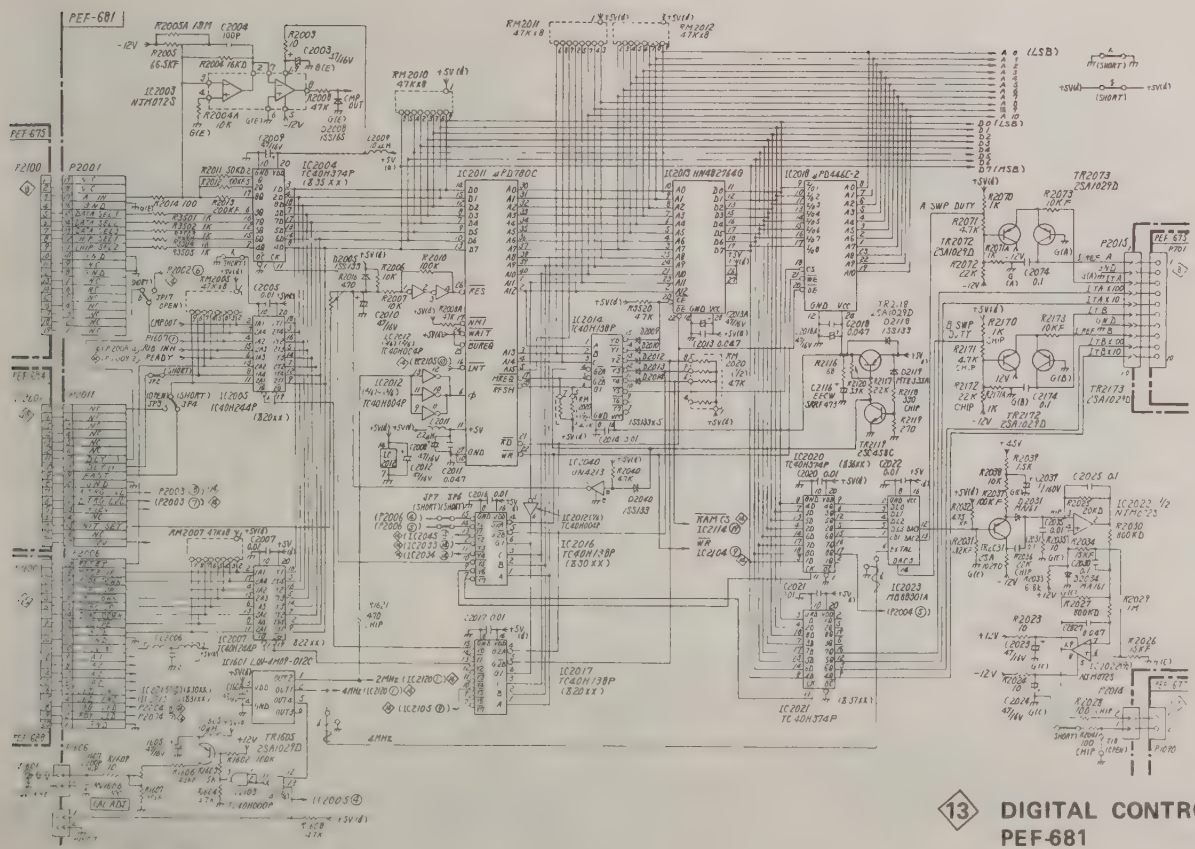
10 HIGH VOLTAGE CKT
CRT CONTROL
PEF-675, 676, 677, 686, 687, 697, 70



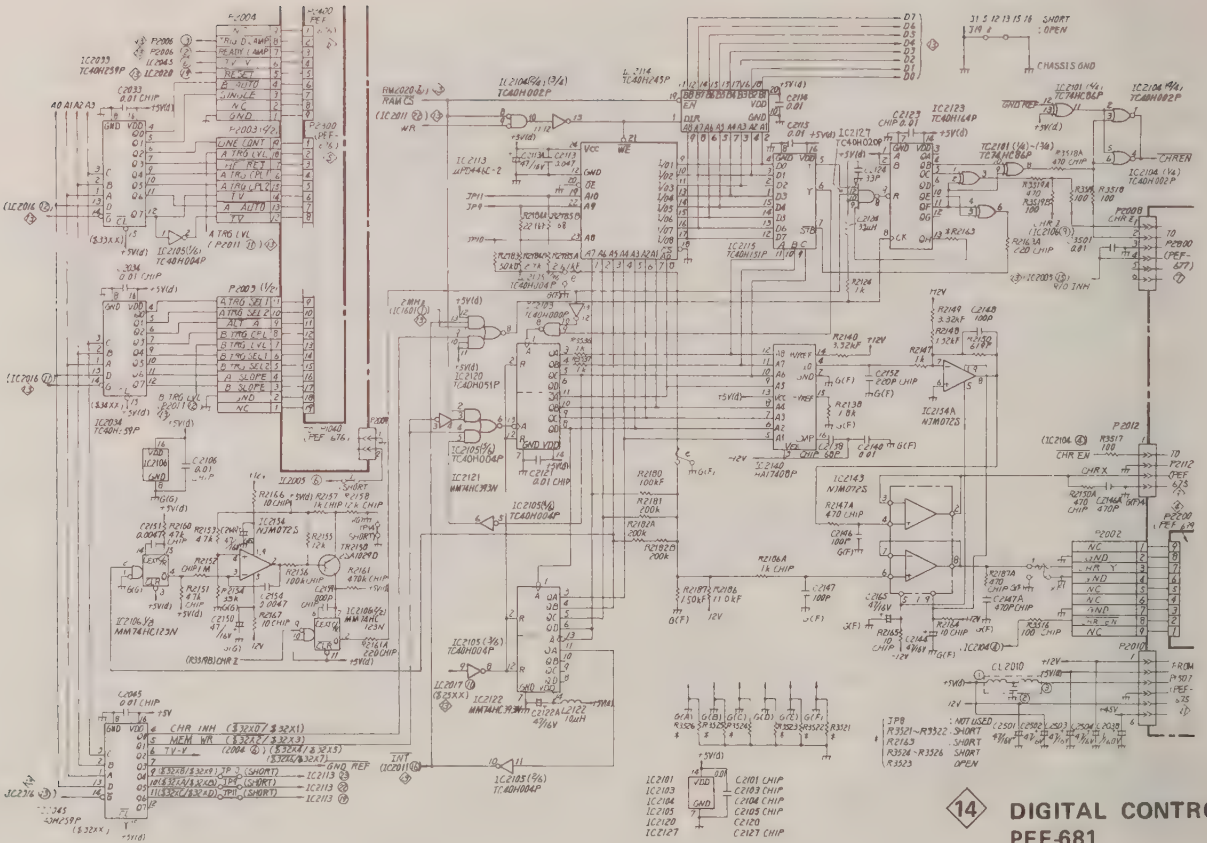
11 POWER SUPPLY PEF-675, 690, 707



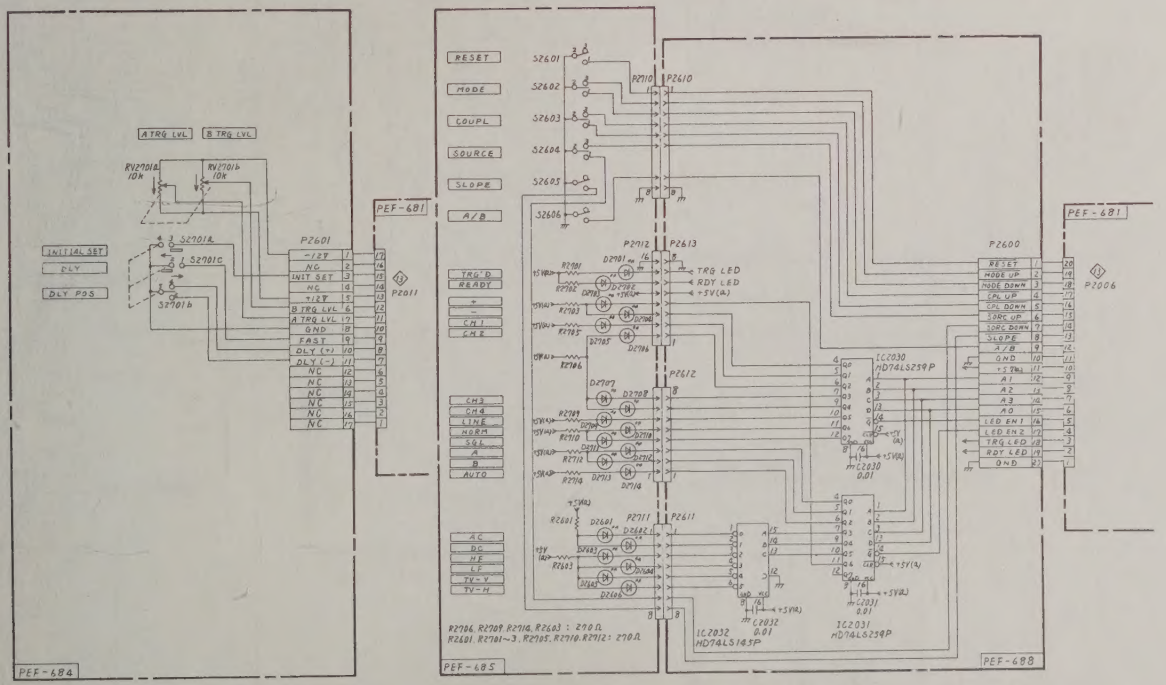
12 V. MODE & H. MODE POSITION CONTROL PEF-682, 683



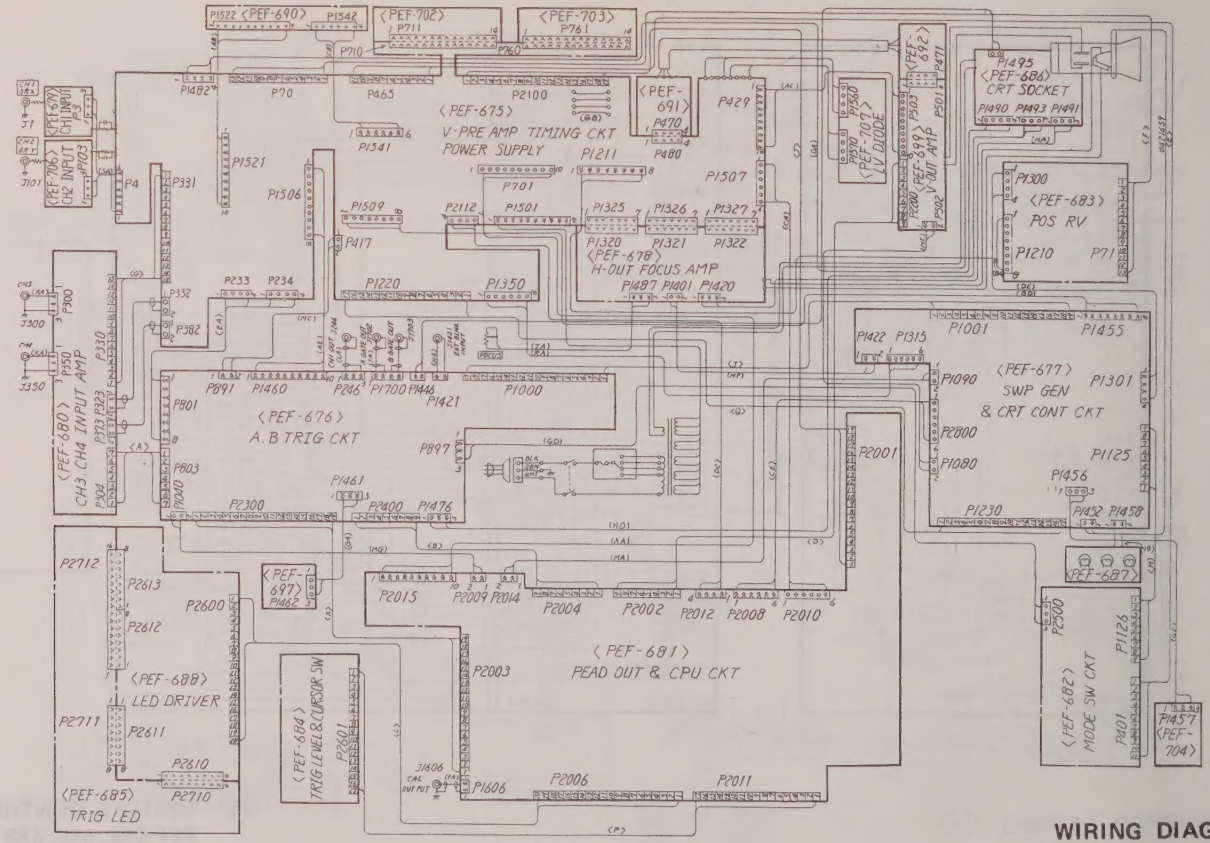
13 DIGITAL CONTROL (1)
PEF-681



14 DIGITAL CONTROL (2)
PEF-681



15 DIGITAL CONTROL (3)
PEF-684, 685, 688



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